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USER'S MANUAL FOR VASCOMP II

THE V/STOL AIRCRAFT SIZING AND PERFORMANCE COMPUTER PROGRAM

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This report describes the use of the V/STOL Aircraft Sizing and Performance Computer Program (VASCOMP II). The program is useful in performing aircraft parametric studies in a quick and cost efficient manner. Problem formulation and data development were performed by the Boeing Vertol Company and reflects the present preliminary design technology. The computer program, written in Fortran IV, has a broad range of input parameters, to enable investigation of a wide variety of aircraft.

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User oriented features of the program include minimized input requirements, diagnostic capabilities, and various options for program flexibility.

UNCLASSIFIED

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BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY
P.O. BOX 16858 • PHILADELPHIA, PENNSYLVANIA 19142

27 August 1980
8-1162-6666

Department of the Navy
Naval Air Development Center
Warminster, Pennsylvania 18974

Attention: Code 6051

Subject: Contract N62269-79-C-0706, "VASCOMP II Computer Program" - Submittal of VASCOMP II User's Manual

Enclosure: (1) VASCOMP II User's Manual (Five Copies)

(2) DD Form 250, Material Inspection and Receiving Report (One Copy)

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1. In accordance with Data Sequence Item A002 of the subject contract Data Requirements List, Boeing Vertol submits Enclosure (1), the VASCOMP II User's Manual.

2. It is requested that you execute the enclosed DD Form 250 and return it to the undersigned at your earliest convenience.

3. With this action, all direct activity required under the subject contract is completed and administrative close-out action is being initiated necessary to preparation and submittal of the final invoice

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VASCOMP II
USER'S MANUAL

(6)

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FOREWORD

VASCOMP, the V/STOL Aircraft Sizing and Performance Computer Program, was originally written during the period June 1966 to March 1967 under NASA Contract NAS2-3142, Mod. 1. From September 1967 to March 1968, a major modification to the computer program led to the development of VASCOMP II under Contract NAS2-3142, Mod. 2. A second modification to the program conducted during the period January 1971 to October 1971 under NASA Contract NAS2-6107, Mod. 1, led to Revision 1 of this document in October 1971.

Past modifications involved updating and expanding the statistical weight trends data and incorporating the weight trends documentation, Reference 2, directly into this document. This revision was conducted under NASA Contract NAS2-6107, Mod. 7, between April and September 1973.

The most recent modifications included a general performance subroutine, a transmission sizing option, accessory horsepower inputs, and additional engine sizing inputs for specified fraction of power and vertical rate of climb.

Numerous comment cards have been added in the Fortran code as an aide to the troubleshooter. Also, where possible, named commons have been used to pass variables among a few subroutines.

Recognizing that in time the program will change to reflect new thinking and grow to include more sophisiticated methods of simulating advanced V/STOL systems, the User's Manual is loose-leaf bound to facilitate updating of the program documentation.

Inquiries regarding the program should be directed to the authors.

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NOTE

Section 5.3 contains a definition of program input variables and indicators; section 6.2 lists the major diagnostic error printouts and describes their probable cause. For ease of reference, these sections are printed on blue and green paper, respectively.

1.0 INTRODUCTION

1.1 BACKGROUND

VASCOMP II is an improved version of VASCOMP, the V/STOL Aircraft Sizing and Performance Computer Program, described in Reference 1. The purpose of the program is to aid comparative design studies of V/STOL aircraft systems by rapidly providing airplane size and mission performance data. The program can be used to define design requirements such as weight breakdown, required propulsive power, and physical dimensions of aircraft which are designed to meet specified mission requirements. The program is also useful in sensitivity studies involving both design trade-offs and performance trade-offs.

During formulation of the program, the following guidelines have been followed:

1. Maintain generality and flexibility:

   A program of this type must be comprehensive and flexible in order to permit an accurate simulation of virtually any V/STOL configuration. It must be capable of approximating the design process involved in layout and sizing of a wide variety of V/STOL aircraft and synthesizing the performance of these aircraft.

2. The program should be easy to use:

   In order to minimize hand computation of input data, the input to the program consists primarily of a series of single point values specifying, for example, the aspect ratio, taper ratio, etc. of the wing and tail surfaces, the geometry of the fuselage, the type of propulsion system, a description of the mission profile, and weights of fixed equipment, fixed useful load and payload. Where necessary to adequately describe certain functional relationships, the input is in tabular form. However, since preparation of data for tabular input is generally more cumbersome and time consuming, this form of input has been kept to a minimum.

3. Minimize computation time:

   In order to minimize computation time, the program makes ample use of optional computation

paths. To eliminate large quantities of null arithmetic, the program avoids calculations which do not apply to the particular aircraft being studied. This is accomplished by means of a series of input indicators that specify the calculations to be performed.

4. The program should be well balanced:

   The program should not be extremely sophisticated in one detail and yet extremely simple in another. To offset the possibility of this occurrence, great care has been taken to examine methods used to describe the aircraft and its operation. As an example, the program does not calculate actual airplane takeoff performance since too many detailed factors are required for this purpose. Rather, the program calculates the power and fuel flow required to satisfy specified thrust to weight requirements. The thrust to weight required is calculated in a separate program and is dictated by the specific aircraft being considered.

1.2 APPLICATION

The program has two primary independent applications, a third which is a combination of the first two, and a fourth option used for obtaining aircraft weight only. The program may be used for the sizing of aircraft for which the type of aircraft and the mission profile are specified. Alternatively, the program may be used for mission calculations for aircraft for which sizing details (gross weight, fuel available, engine power and fuel consumption, etc.) are known. As a combination of these two capabilities, the program may be used to first size an airplane for a given mission and then calculate the off-design-point performance for other missions. The option of calculation to be used is specified to the program by means of an input "option indicator".

The program has been written in a manner to make it directly applicable to sensitivity studies to determine the effect of variations in weight, drag, engine characteristics, etc. This is accomplished by use of incremental multiplicative and additive factors applied to the gross weight, component drag and fuel required equations. For the most part, the multiplicative factors are nominally equal to unity and the additive factors are nominally equal to zero. However, to determine the effect, for example, of a 10 percent increase in drive system weight, the appropriate multiplicative factor can be set to 1.10 and the sizing program rerun.

The program contains size trends equations which reflect the variation of aircraft dimensions with gross weight, detailed statistical weight trends equations, a routine for sizing of engines to match airframe requirements, a comprehensive library of engine cycle data, and a variety of optional procedures for calculating propeller performance for turboprop airplanes.

The program can be used to study any aircraft which uses fixed wing lift for primary cruise flight. It is not intended to be used for analysis of aircraft which employ rotary wing lift for forward flight.

2.0 SPECIFICATION OF AIRCRAFT CHARACTERISTICS

Specification of aircraft characteristics to the program is made in a variety of ways: through use of input indicators which specify the types of calculations to be made, through use of weights factors and constants, aerodynamics data, propulsion information, and through use of mostly nondimensional geometric information.

2.1 AIRCRAFT GEOMETRY

It is assumed that a typical sizing analysis starts with known payload characteristics, both in terms of payload weight and volume requirements. The volume requirements are usually reflected in length, height, and width of the constant diameter (cabin) section of the airplane. Adding a nose and tail section of reasonable fineness ratio onto the cabin section completes the fuselage geometry and leads to a body of known dimensions. A special option of the program permits the fuselage geometry to be calculated to match known passenger requirements for commercial applications. Wing geometry may be dictated by the requirements to accommodate multiple propellers while maintaining reasonable wing chord to propeller diameter ratios, as in the case of a tilt wing airplane, or it may be dictated by required wing loading-aspect ratio combinations. Tail surface geometry is usually dictated by requirements on tail volume coefficients. Since the fuselage length is generally known and fixed in length, the tail moment arms may be approximated and input as fixed quantities. Alternatively, if the tail surface size is a known value, it may be input to the program as a fixed constant. Primary engine nacelle size is set by type of engine and by engine size (which, in turn, is dictated by power requirements). Lift engine size is set by type of engine, engine size, and by the number of engines which may be clustered together.

Figure 2-1, Parts 1 and 2, of a hybrid V/STOL airplane illustrates the type of information concerning the aircraft geometry which may be required of the user of the program. These data specify nondimensional distances from the aircraft centerline to the engines, to the main gear, and to concentrated loads, propeller overlap and clearance factors, and other parameters which specify the geometric layout of the aircraft. A list of these input variables is included in Section 5.3.1.

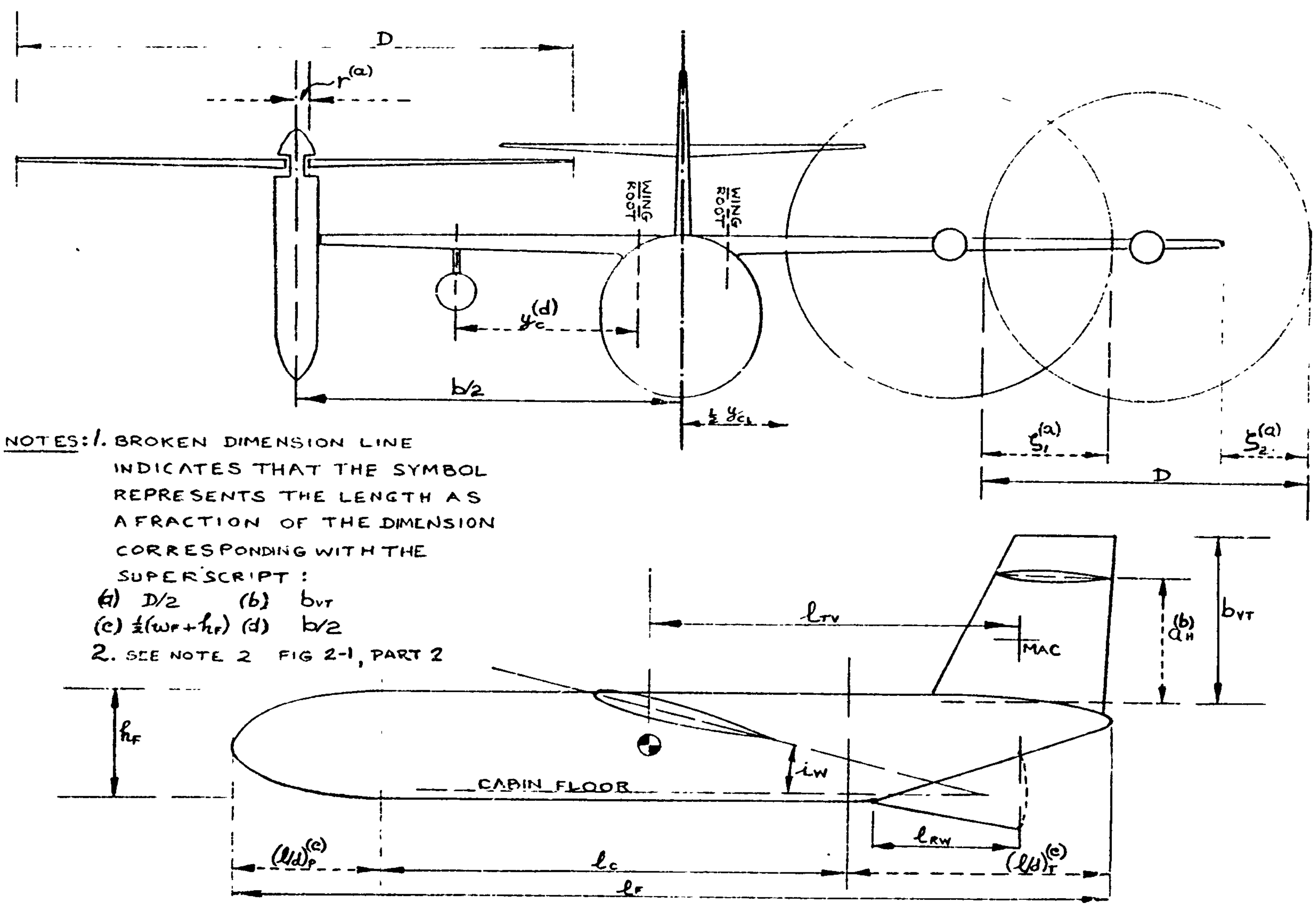


Figure 2-1. Typical Aircraft Geometry (Part 1 of 2).

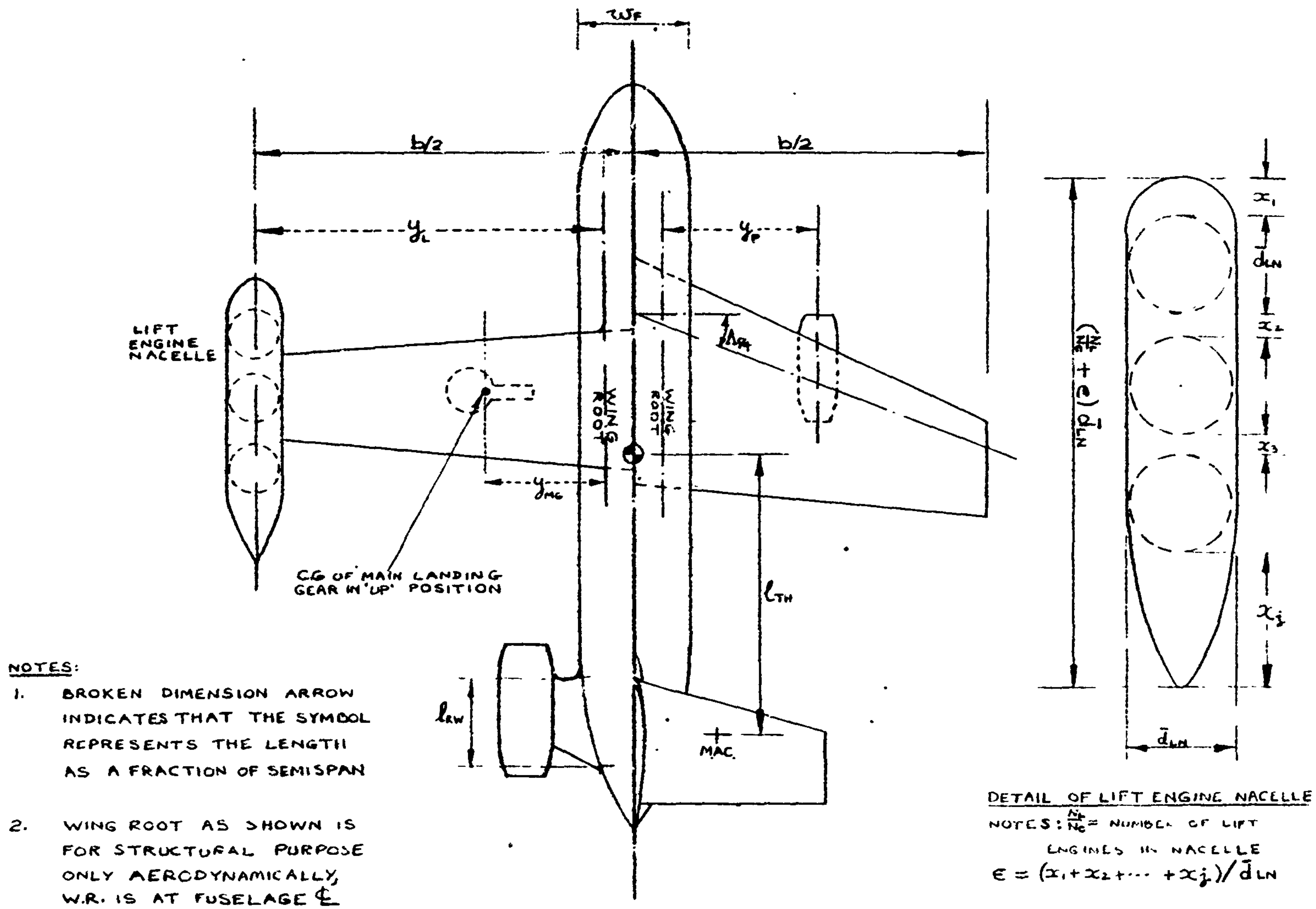


Figure 2-1. Typical Aircraft Geometry (Part 2 of 2).

2.2 PROPULSION SYSTEM

This program permits the use of either a single, primary propulsion system or a combination of a primary system and lift propulsion system. For the primary system, turboshaft, turbofan, turbojet or convertible cycles may be used. Lift fan and lift turbofan cycles are used to represent the lift propulsion system. The program includes a standard library of eighty-one different generalized engine cycles, as shown in Table 2-1. The user of the program may either select the desired engine cycle(s) from the standard library or input the characteristics of any arbitrary engine cycle he may choose.

The library engines are unrestricted in performance over their operating system range (dictated by power setting limits). However, the user, at his discretion, may include limits on engine operation by setting maximum values of fuel flow, torque, or gas generator or power turbine shaft rpm. In addition, nonlinear scaling effects of real engines may be included by input of Reynolds number-based correction factors. Degradation in performance of turboshaft engines operating at nonoptimum power turbine speed will be calculated by the program at the option of the user. The library engine cycles may thus be used with no additional input or, by appropriate additional input, may be made to include the effects of multiple operating restrictions and other factors characteristic of real engine cycles.

During a sizing calculation, the engine cycles may be "scaled" or fixed in size. That is, if the user desires, the program will calculate the engine size required to meet the mission requirements, or alternatively, he may input engines of specified size. In the case of aircraft employing multiple propulsion systems, the primary system may be used to provide part of the lift thrust or power, and the lift engines will be sized to provide the remaining required thrust or power.

2.3 AIRCRAFT WEIGHT SUMMARY

A detailed aircraft weight summary is provided by the program through use of statistical weight trend equations. A description of, and justification for, these equations is

TABLE 2-1
LIST OF ENGINE CYCLES

	1970	INTERMED-IATE	ADVANCED
<u>PRIMARY PROPULSION</u>			
TURBOSHAFT			
ENGINE PRESS. RATIO	13, 16	13, 16, 19	13, 16, 19, 22
TURB. INLET TEMP.	2600°R	2900°R	3200°R
TURBOJET			
ENGINE PRESS. RATIO	13, 16	13, 16, 19	13, 16, 19, 22
TURB. INLET TEMP.	2600°R	2900°R	3200°R
TURBOFAN			
ENGINE PRESS. RATIO	16, 20	16, 20, 24	16, 20, 24, 28
TURB. INLET TEMP.	2600°R	2900°R	3200°R
FAN BYPASS RATIO	2, 4, 6	2, 4, 6	2, 4, 6
<u>LIFT PROPULSION</u>			
LIFT ENGINES			
ENGINE PRESS. RATIO	7	7	7
TURB. INLET TEMP.	2400°R	2700°R	3000°R
FAN BYPASS RATIO	2, 4, 6	2, 4, 6	2, 4, 6
LIFT FANS			
ENGINE PRESS. RATIO	13, 16	13, 16, 19	13, 16, 19, 22
TURB. INLET TEMP.	2600°R	2900°R	3200°R
FAN BYPASS RATIO	8, 11, 14	8, 11, 14	8, 11, 14

given in Reference 2. Three major categories of weights are calculated: the propulsion group, the structures group, and the flight controls group. The weight trends subroutine is described in detail in section 4.9.

2.4 AERODYNAMIC CHARACTERISTICS

The aerodynamic data which are calculated by the program are the airplane drag and lift curve slope. The lift curve slope is used for calculation of gust load factor and for calculation of angle of attack required during climb and descent. Drag data may be input to the program in a variety of forms ranging from input of a single point value of either drag coefficient or of flat plate area to input of a detailed drag summary. Scaling effects on drag based upon Reynolds number corrections are included. The program will automatically calculate the compressibility drag rise on the basis of an approximate semi-empirical technique. If the user prefers, he may input tabulated values of the drag rise. Spanwise loading efficiency (Oswald's factor) may be either input to the program or may be internally calculated by the program.

3.0 PROGRAM OPERATION

3.1 GENERAL

3.1.1 The Option Indicator

As previously described, the program has two major options and a third which is a combination of these two. The specific option to be used is selected by means of an input "option indicator" abbreviated OPTIND.

OPTIND = 0

This is an iterative routine which determines only the aircraft weight, dimensions, and power.

OPTIND = 1

This is an iterative routine which determines the aircraft weight, dimensions and required power to satisfy a prescribed mission flight profile. In addition to the flight profile, certain characteristics describing the type of aircraft are specified such as the wing aspect ratio, thickness ratio, the wing loading or disc loading, the engine cycle, etc.

OPTIND = 2 or 3

These options are used to calculate the flight performance of an aircraft for which the size is fixed. In addition to the aircraft characteristics described above, the power available, aircraft dimensions, etc. are input to the program. A flight profile is also specified. The program then calculates the performance history of the aircraft for the specified mission.

If OPTIND = 2 is selected, the aircraft gross weight is input and the fuel required to fly the specified mission is determined. This option is useful for solving many different performance problems where it is desired to constrain gross weight such as calculating climb performance, cruise performance, or payload-range capability.

If OPTIND = 3 is selected, the operating-weight-empty is input and takeoff gross weight and required fuel load is determined. This option is useful for calculating various overload off-design weights and for determining ferry performance.

Combined Option

This option permits the user to size an aircraft for a "design-point" mission and then to calculate the off-design-point performance of the sized aircraft for a variety of additional missions. Basically, this option causes the program to run option number one (OPTIND = 1), save the sizing data generated in that option, and then input this information into the performance option (OPTIND = 2).

3.1.2 Description of Mission Profile

The performance calculation subprogram in VASCOMP II, consisting of nine individual subroutines, permits the simulation of aircraft performance for virtually any mission flight profile. A typical performance analysis is made up of a series of elements which, in building block fashion, allows the user of the program to perform a wide variety of studies. The elements of a typical performance analysis are:

a. Segment - A segment of a mission profile is a unique portion of the mission such as a cruise or a climb. A segment starts with a set of initial conditions of one or more of the variables of state (altitude, range, weight, etc.) and ends when a terminal condition (or conditions) has been satisfied.

b. Hop - A hop is defined as a set of segments ending at some logical terminal locations (such as ground level at the desired range). Thus, a hop might consist of flying from location "A" to location "B" by means of combining the following segments: taxi, takeoff, climb, cruise, descent, landing, and taxi.

c. Leg - A leg of a mission is herein defined as a set of hops ending in a re-fueling of the aircraft. Thus, a leg might consist of flying from location "A" to "B", then to "C", at which point the aircraft is refueled.

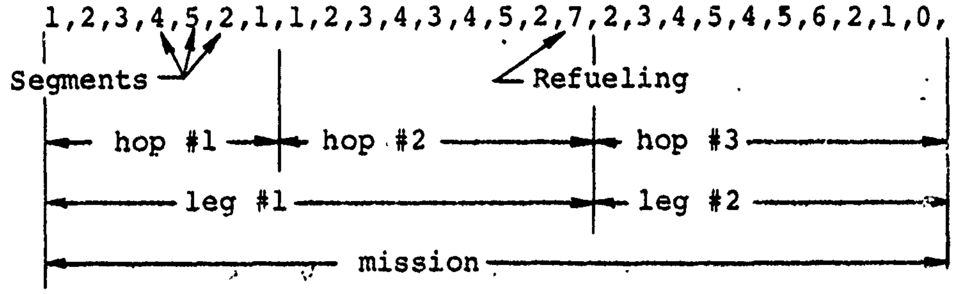
d. Mission - A mission is defined in this program as a set of legs (or hops or segments) which satisfy some specific operational requirement. In this program, the mission is the basic element for which the aircraft is sized.

e. <u>Case</u> - A case is a consecutive series of missions for the same aircraft. This program permits the user to analyze a case which consists of a mission for which an aircraft is sized, followed by a different mission which the now-sized aircraft performs, followed by yet additional missions.

The performance calculations subprogram consists of ten individual performance segments, specified by means of an input indicator, SGTIND. The segments are taxi (SGTIND = 1), hover (SGTIND = 2), climb (SGTIND = 3), cruise (SGTIND = 4), descent (SGTIND = 5, loiter (SGTIND = 6), an increment in weight of fuel (SGTIND = 7) or payload (SGTIND = 8), a transfer of altitude (SGTIND = 9), and general performance (SGTIND = 11). The end of the mission is specified by an input SGTIND = 0. An array of segment indicators is input to the program to specify the mission being studied. Thus, a typical array might be:

SGTIND =

1,2,3,4,5,2,1,1,2,3,4,3,4,5,2,7,2,3,4,5,4,5,6,2,1,0,



At the end of any leg, the sum of segment fuel required to perform that leg is stored in the computer. At the end of the mission, the largest of these stored values is used to determine the aircraft sizing requirements when OPTIND = 1. An end of a case is specified by an input SGTIND = 100. Since an end-of-case is also always an end-of-mission, it is not necessary to end a case by a SGTIND = 0 followed by SGTIND = 100. SGTIND = 100 always takes precedence over SGTIND = 0. The distinction between a mission and a case is most useful when it is desired to size an aircraft for a specified mission followed by analysis of the off-design-point performance of the "sized" aircraft on other missions. As an example, with OPTIND = 1 (sizing option) the following array of SGTIND might be used:

SGTIND =

1, 2, - - - - 0,	2, - - - - 0,	1, - - - - 0,	1, - - - - 100
1st mission	2nd mission	3rd mission	4th mission

$\longleftarrow$ Case $\longrightarrow$

The program will size the aircraft for the first mission and then analyze the performance of the "sized" aircraft for the second, third and fourth missions. Up to 50 consecutive segments may be included in a single case, arranged in any arbitrary series of hops, legs, and missions. Up to 10 of any specific segment may be included in any case. Thus, a case might consist of several missions, each mission having several different cruise segments.

Each segment is a discrete element of the mission, independent of any other segment with the exception of the influence on the altitude, range, weight, and time. That is, the first cruise of a case might be at cruise power at standard atmospheric conditions and the second cruise could be at best specific range for a nonstandard day.

At the start of a case, the user inputs values for initial conditions of altitude, range, weight, and time. The first segment of the case uses these values as initial boundary conditions and the segment ends at a specified terminal condition. The final values of altitude, range, weight, and time then become, in turn, the initial values for the following segment.

The final, or terminal, condition varies depending upon the segment. Terminal conditions for each segment, input by the user, are:

<u>Taxi</u> - increment in time

<u>Takeoff, Hover, and Landing</u> - increment in time

<u>Climb</u> - altitude at end of climb

<u>Descent</u> - altitude at bottom of descent and, for certain options, range at end of descent

<u>Loiter</u> - increment in time

<u>Change of Fuel Weight</u> - increment in weight and increment in time

<u>Change of Payload Weight</u> - increment in weight and increment in time

<u>Transfer Altitude</u> - final altitude

<u>General Performance</u> - increment in velocity

Segments 2 through 6 (takeoff, hover, and landing through loiter) and segment 11 (general performance require, in addition to terminal conditions on one of the variables of state, an input value for the step size to be used in the calculations. The step size specifies both the increment in the primary variable which is used in the calculations and the increment between successive printouts. Printouts occur at even integral multiples of the primary variable. Thus, if an aircraft is required to climb from a starting value of altitude of 6300 feet to a final value of 29,500 feet, and the step size is specified as 1000 feet, the program will calculate and print at 6300 feet, 7000 feet, 8000 feet, - - - - - - - 28,000 feet, 29,000 feet, 29,500 feet. As the step size is decreased, the program accuracy improves, but the computing time lengthens.

Atmospheric conditions may vary from segment to segment. For example, the first segment, a climb, may be for a standard atmosphere; the second segment, a cruise, may use a constant increment in temperature above standard;

and the third segment, another climb, may use a nonstandard temperature versus altitude table. The third atmosphere option requires a tabular input of temperature ratio versus altitude. Only one nonstandard tabular atmosphere may be used in a single case.

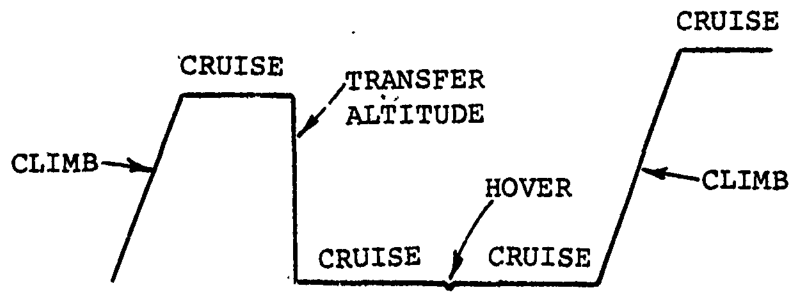
3.1.3 Special Flight Path Control Options

Two special options on flight path control aid in doing certain types of studies. These are:

a. $V_{LIM}IND$ - This limiting-speed indicator will permit the user to fly a mission with a speed constraint such that at altitudes of 10,000 feet or less the airplane is restricted from flying at equivalent airspeeds greater than 250 knots in conformance with federal regulations. The mission may be made up of any arbitrary order of segments such as climb, cruise and descent.

b. $h_{OPT}IND$ - This indicator will permit the user to fly a mission at the optimum altitude for best fuel consumption. The program will automatically determine the best altitude for any cruise segment which is preceded by either a climb segment or a transfer of altitude. If the cruise is preceded by a climb, the program will determine the flight altitude which minimizes the sum of the fuel for climb and cruise. If the cruise is preceded by a transfer altitude, the program will determine the altitude for the best fuel consumption during cruise only.

In addition to specifying that optimum altitude flight is desired during the mission, the user may specify a maximum altitude permitted for each cruise segment. This is specified by means of the h_{MAX} input for the preceding climb or the h_{FINAL} input for the preceding transfer altitude. The maximum altitude specification is useful in studying missions for which some of the cruise segments are to be optimized while other cruise segments are to be flown at known altitude such as the high-low-low-high mission shown on the next page in which the low altitude segments represent sea level dashes. For this mission, the user specified $h_{FINAL} = 0$ for the transfer altitude segment.



3.1.4 Propulsive Efficiency

Propeller efficiency can be calculated in three different ways for aircraft with turboshaft engines. The option chosen is specified by means of a propulsive efficiency indicator, ηpIND. The options range from (a) input of a set of point values of efficiency to (b) input of a prop map table to (c) automatic calculation of propeller performance. The option chosen will depend on the type of problem being studied as each of the means of calculating prop performance has features which may be desirable under certain conditions. These options are described in more detail in Section 4.5. A fourth propulsive option available to the user is to input a fan map table of Mach number versus thrust for fan propelled aircraft.

A value for the propulsive efficiency may also be input for jet engines during the takeoff, hover, and landing segment (SGTIND = 2). This efficiency may be used to simulate turning efficiency for a jet engine during takeoff. Similarly, a value for efficiency for lift engines in takeoff, hover, or landing may be input. This is discussed in more detail in Section 4.10.2

3.2 PROGRAM OPTIONS

Flexibility of operation and generality of approach have been accomplished by use of many optional computation paths. The path to be used is selected by the user through use of a series of input indicators. Besides the option indicator, previously described, the program indicators fall into seven categories:

propulsion indicators, aerodynamics indicators, size trends indicators, mission performance indicators, flight path control indicators, an atmosphere indicator, and an optional print indicator. The indicators and their use are described below. A summary list of all indicators and their values is included in Section 5.3.2.

3.2.1 Propulsion Indicators

a. ENGIND - Three different classes of cruise engines are included in the program. They are "horsepower producing" engines, "thrust producing" engines, and convertible engines. The horsepower producing engines which are included in the standard engine library are turboshaft engine cycles. The thrust producing engines in the engine library are either turbojet or turbofan engines. Convertible engine cycles can be simulated by selecting a cruise turbofan cycle, plus properly setting the engine indicator, ENGIND. If ENGIND is input as zero, a power producing cycle is selected. If ENGIND is input as 1, a thrust producing cycle is selected. If ENGIND is input as 2, a fan (thrust producing) cycle will be selected and the program flow will simulate operation of a convertible engine cycle.

b. LFTIND - A primary (or cruise) engine cycle is selected for each aircraft. In addition, a lift engine cycle may be selected. The selection of separate lift propulsion is specified to the program by means of the indicator, LFTIND. LFTIND = 0 indicates only cruise propulsion is selected while LFTIND = 1 indicates both cruise propulsion and lift propulsion systems are included on the aircraft.

c. FIXIND - Engines selected for aircraft being studied in the program may be either "fixed" in size or "rubberized." If the engines are "rubberized," the engine sizing subroutine calculates the maximum power or thrust of the engines required to satisfy certain specified criteria. If the engines are fixed in size, the user inputs the level of maximum power or thrust for the engines and the engine sizing subroutine is bypassed. The user specifies the option of calculation by means of the input indicator, FIXIND. If FIXIND is set to

zero, the engines are fixed in size. If FIXIND is set to unity, the engine sizing subroutine is used to calculate the size of the "rubberized" engines.

d. ESZIND - For aircraft which do not contain separate lift propulsion, the program permits the user to size the primary engines either for takeoff conditions only or for the more critical choice of takeoff or cruise. This is specified by means of the engine sizing indicator, ESZIND. If ESZIND is input to zero, the program will size the engines for takeoff conditions only. If ESZIND is input as unity, the program will size the engines for takeoff, then cross-check the engine size required for cruise conditions, and pick the more critical of the two conditions.

e. WDTIND, QIND, N1IND, N1θIND, N2IND - These indicators specify to the program that the primary engine performance is restricted by a maximum level of fuel flow, torque, gas generator shaft rpm, gas generator referred shaft rpm, or power turbine (output) shaft rpm. An input zero value for these indicators will permit operation restricted only by power setting (turbine temperature) limits. A unity input for any of the indicators will cause the engine operation to also be restricted by a maximum level of the appropriate variable. More than one of these indicators may be set to unity at the same time, thus simulating performance of an engine operating with multiple restrictions. N2IND has a third possible value which the user may input for turboshaft engines, N2IND = 2. This input specifies that the engine is operating a known discrete value of output shaft speed (in general, not the optimum value). If this option is used, the user inputs the level of N_{II} for each flight segment, and the program will calculate the effect on engine performance.

f. LWDIND, LN1IND, LN2IND - These indicators are similar to those described in (e.) above except that they apply to the lift propulsion system. A unity input for any of these indicators will cause the lift engines to be restricted in performance by a maximum level of fuel flow, N_I, or N_{II}. Since the lift

engines are either lift fans or lift turbofans, they are assumed to always operate at optimum N_{II}, and therefore there is no option for the lift engines similar to the previously described N2IND = 2.

g. RNOIND - The performance of real engines is sensitive to scaling effects. That is, doubling the maximum static power of the engine at sea level for standard atmospheric conditions by increasing the physical size of the engine will not cause a corresponding doubling of the power at other operating conditions. This nonlinear behavior is due to the influence of variations in the Reynolds' number at the compressor inlet. RNOIND permits these effects to be accounted for on turboshaft engines through use of an input table of a correction factor on power available. If the indicator is set to unity, the tabulated correction factor may be input and will be used by the program to account for scaling effects. A zero input for the indicator will cause the program to assume that perfect scaling occurs.

h. POWIND - This indicator specifies the limiting power setting to be used in climb, cruise, and for engine sizing at cruise conditions: maximum (POWIND = 0), military (POWIND = 1), and normal (POWIND = 2). A separate value of this indicator is input with each climb and cruise and for engine sizing.

i. η_pIND - This indicator permits the user to select one of the four different methods for predicting propeller performance for turboprop airplanes. If η_pIND is input equal to zero, the user can specify a set of point value efficiencies for each of takeoff, climb, and descent and a table of efficiency vs. Mach number for cruise and loiter. An input of η_pIND = 1 will permit the user to load in a propeller performance map to be used during takeoff, climb, cruise, and loiter while an input of η_pIND = 2 will permit use of an automatic subroutine within the program for calculating prop performance. For η_pIND = 3 the user inputs a fan performance map. It is anticipated that this latter option will be used for the majority of sizing and performance studies. The input prop map

option will typically be used in cases where detailed test data is available on prop performance and it is desired to closely represent a specific propeller. The first option, permitting input of point values, is most useful for sensitivity studies or where propeller choice has not yet been made and only representative values of efficiency are desired. A more detailed discussion of these options is contained in Section 4.5.

3.2.2 Aerodynamics Indicators

a. DRGIND - The aerodynamics calculations subroutine includes a set of semi-empirical equations to calculate drag rise due to compressibility effects. If specific information about the drag rise of the aircraft being studied is known, this may optionally be input to the program by means of an input table. The method of calculating compressibility drag is specified to the program by means of the indicator DRGIND. If DRGIND is input as zero, the program uses the semi-empirical equations to calculate an approximate drag rise. If DRGIND is input as unity, the user may input a three-dimensional table of compressibility drag coefficient as a function of lift coefficient and Mach number.

b. OSWIND - The span loading efficiency factor (Oswald's efficiency factor) may be calculated by the program from an approximate relationship as a function of wing aspect ratio. If the user prefers, he may input a fixed value of the efficiency factor to the program. An input of OSWIND = 0 permits the user to input a fixed value for efficiency. An input of OSWIND = unity will cause the program to use the approximate equation to calculate the value for efficiency.

3.2.3 Size Trends Indicators

a. FDMIND - The fuselage dimension indicator permits optional calculations of fuselage dimensions. The user studying an aircraft with known fuselage length and wetted area may input these values to the program by setting FDMIND = 0. However, the user, knowing only

the length of the cabin (or constant diameter) section of the aircraft, may have the program calculate the total aircraft length and wetted area for him by inputting FDMIND = 1 and the values for nose and tail section fineness ratios. A third option, FDMIND = 2, will permit the user to size the fuselage to accommodate known passenger requirements for commercial service. The user inputs the number of passengers, the unit seat width, seat pitch, number of aisles, aisle width, and number of seats abreast for tourist class and also for first class service. He also specifies certain data on galley size and lavatory size requirements by means of the indicators described below.

b. GALLEY INDICATOR - This indicator will permit the user to directly input the galley area required by setting this indicator to 1.0 or will permit use of a trend equation based on number of passengers carried by inputting a value of zero for the indicator. Input of the GALLEY INDICATOR is required only if FDMIND = 2.

c. LAVATORY INDICATOR - This indicator will permit the user to directly specify the number of lavatories (LAVATORY INDICATOR = 1) or to use a trend equation based on number of passengers (LAVATORY INDICATOR = 0). It is assumed by the program that each lavatory is 16 sq ft in floor area. If the user desires smaller lavatores he may represent that by input of a fractional number of lavatories. This indicator is required only when FDMIND = 2.

d. WDMIND - The wing dimension indicator permits the user to calculate wing dimensions in one of two ways. The wing dimensions may be dictated by either input value of wing loading and aspect ratio (WDMIND = 0) or by propeller geometry as in the case of a tilt wing aircraft (WDMIND = 1 or 2).

e. HTIND, VTIND - These indicators permit the user to input fixed-size tail surfaces to the program or, optionally, to have the program calculate the tail surface size based upon input volume coefficients.

If a unity value is input, the program will calculate the size based upon tail volume

coefficient. If either HTIND or VTIND is set to two (2.0), the horizontal or vertical tail (or both) may be input as fixed size surfaces.

f. PDMIND - The prop dimension indicator, PDMIND, permits the user to define the major propeller dimensions - diameter and chord - in various ways. The diameter may be directly input to the program (PDMIND = 1 or 3) or may be calculated from an input of the disc loading (PDMIND = 2 or 4). The chord, represented by activity factor or solidity may be calculated from an input activity factor (PDMIND = 1 or 2) or from an input thrust coefficient to solidity ratio, C_T/σ (PDMIND = 3 or 4). Depending upon which of the four values of the indicator is chosen, any combination of the methods for predicting chord and diameter may be selected.

3.2.4 Mission Performance Indicators

a. SGTIND - The mission profile flown by the aircraft may be made up of an arbitrary sequencing of nine discrete profile segments. The segment selected is specified by means of the segment indicator, SGTIND. The segments are: taxi (SGTIND - 1), takeoff, hover and landing (SGTIND = 2), climb (SGTIND = 3), cruise (SGTIND = 4), descent (SGTIND = 5), loiter (SGTIND = 6), a change of fuel weight (SGTIND = 7), a change of payload weight (SGTIND = 8), a transfer of altitude (SGTIND = 9), and general performance (SGTIND = 11). By appropriate sequencing of the input values for the segment indicator, the mission profile may be made up of any arbitrary combination of these discrete elements. The mission is terminated by an input value for segment indicator = 0.

b. TOLIND - The indicator TOLIND is input with each takeoff, hover, and landing segment and dictates the manner in which power is calculated. TOLIND = 1 may be used with airplanes which have double propulsion systems (primary and lift) or which have primary propulsion alone. A required thrust-weight ratio is input to the program. If the airplane has lift engines, as much thrust as is necessary will be taken from the lift engine system up to maximum thrust level. If maximum lift engine thrust is insufficient, the available lift engine thrust will be augmented with primary engine thrust. TOLIND= 2 may be used only for airplanes which have both primary and lift engine systems. This option is similar to TOLIND = 1 in the sense that a required thrust-weight ratio is input to the program. The

difference lies in the fact that equal percentages of available thrust are taken from primary and lift systems. TOLIND = 3 is used if the user wants to specify the percentage of maximum power being used from the engine system(s). The resultant thrust-weight ratio is calculated by the program.

c. CLMIND - Four types of climb calculations are permitted: maximum rate of climb (CLMIND = 1), constant equivalent airspeed (CLMIND = 2), constant Mach number (CLMIND = 3), and constant true airspeed (CLMIND = 4).

d. CRSIND - Six types of cruise missions are included in the program. They are: cruise at fixed cruise power (CRSIND = 1), cruise at constant true airspeed (CRSIND = 2), cruise at airspeed for best specific range (CRSIND = 3), cruise at the speed for 99% of best specific range (CRSIND = 4), cruise-climb (constant W/δ) at the speed for best specific range (CRSIND = 5), or cruise-climb at the speed for 99% of best specific range (CRSIND = 6).

e. DESIND - Eight different descent paths may be calculated by the program. They are of four types: descent at maximum speed, (DESIND = 1,2), descent at idle power (DESIND = 3,4), descent at constant equivalent airspeed (DESIND = 5,6) and descent at constant Mach number (DESIND = 7,8). The odd-numbered values are used when it is desired to specify the terminal range at the end of descent, the even numbered values when it is not so desired.

f. LTRIND - The loiter segment may be used to simulate an additional requirement for reserve fuel, or may be included as part of the mission fuel. In either case, the fuel required for loiter would be used as part of the total fuel required to size the aircraft. However, if the fuel is to be used for reserve purposes only, the aircraft weight will not be reduced by the amount of loiter fuel. The option is specified to the program by means of the input indicator LTRIND. If LTRIND is input as zero, the program will assume the loiter fuel is part of reserves. If ITRIND is input as unity, the loiter fuel will be included in the mission fuel.

g. WGTIND - The change fuel and change payload segments may be used to simulate refueling, unloading or loading of passengers, or a fuel drop. There is no restriction on the amount of fuel or payload which may be removed at any point in the mission. However, during a sizing run, it would be undesirable to increase the airplane weight (by adding fuel or payload) to a value which exceeds the initial gross weight of the airplane. This is because the design gross weight, upon which the subsystem weights depend, is assumed to be the same as the initial gross weight at the start of the mission. During a performance run (OPTIND = 2) this restriction does not apply and the user is given the option of overloading the airplane at any point of the mission. If WGTIND is input as zero the program will not permit the maximum weight to exceed the design gross weight. This is useful if it is desired to refuel to capacity at some point in the mission. If WGTIND is input as unity (and if the performance option is being run) the program will permit the airplane weight to exceed the design gross weight. This is useful for parametric performance studies. For example, the user can specify an array of SGTIND = 7, 4, 0, 7, 4, 0, 7, 4, 0, -----7, 4, 100. When this is done, the program will calculate the performance in cruise at a series of different aircraft weights. The "7" segment is used to increment the design gross weight to any value of weight desired for the following cruise.

h. XMSNIND = Indicator that controls drive system transmission sizing. When XMSNIND = 0.0 the transmission will be sized at an input fraction (LOC 0258) of the primary installed power. If XMSIND = 1.0 the transmission is sized at a specified fraction of power required to hover or cruise at design conditions (more critical of the two conditions is selected).

For both XMSNIND conditions the designed transmission torque is used in the weight trends subroutine to determine transmission weight.

3.2.5 Flight Path Control Indicators

a. V_{LIM}IND - Setting this indicator to a value of 1.0 will automatically limit the flight speed at altitudes below 10,000 feet to 250 knots EAS or less. If V_{LIM}IND is input as zero, no such constraint on equivalent airspeed will occur.

b. $h_{OPT}IND$ - By inputting $h_{OPT}IND = 1.0$, the program will automatically determine the cruise altitude for minimum fuel consumption for any cruise which is preceded by a climb or a transfer altitude. For cruise segments which are preceded by a climb the program will find the cruise altitude for which the sum of climb fuel and cruise fuel is minimized. The user can also specify a maximum permissible altitude for each cruise segment. If $h_{OPT}IND = 0$ is input, the program will not do an optimum altitude search for the cruise segments.

3.2.6 Atmosphere Indicator

a. ATMIND - The atmosphere for each individual mission profile segment and for the engine sizing calculations may be either a standard or non-standard atmosphere. Thus, the climb may be run on a nonstandard atmosphere folowed by a cruise for standard day conditions. Three options (one for standard atmosphere, the other two for a nonstandard atmosphere are available. For the performance calculations, the type of atmosphere to be used is specified to the program by means of the atmosphere indicator, ATMIND. If ATMIND is input as zero, the program will use a standard atmosphere. ATMIND = 1 specifies a nonstandard, constant increment in temperature above standard while ATMIND = 2 specifies a nonstandard atmosphere requiring a tabular input of temperature ratio versus altitude.

3.2.7 Optional Print Indicator - Two different forms of printout are available for the mission performance data. By setting OPTIONAL PRINT INDICATOR = 0 a standard printout will occur. This consists of time, range, fuel used, aircraft weight, pressure altitude, true airspeed, engine turbine temperature, an engine code which specifies the condition which is dictating the engine operating point, and a power fraction which is the instantaneous fraction of maximum power which is being used. These data are printed for all performance segments. In addition, depending upon which segment is being used, the standard printout will include such parameters as rate of climb, equivalent airspeed, specific range, flight path angle, etc.

More detailed data may be obtained by setting the OPTIONAL PRINT INDICATOR = 1.0. The data printed will then include airplane lift and drag in pounds, fuel flow rate, actual horsepower or thrust, C_L, C_D, propeller C_P, J, and C_T, etc.

The printout available from the program is described in more detail in Section 6.

PROGRAM FLOW

Figure 3-1 indicates, conceptually, the operation of the program. Program flow is monitored by a general control loop which controls the operation of a series of peripheral programs. These include twelve minor subroutines, four major subroutines, a major subprogram, and a library of engine cycle data. The characteristics of these routines are summarized in Table 3-1.

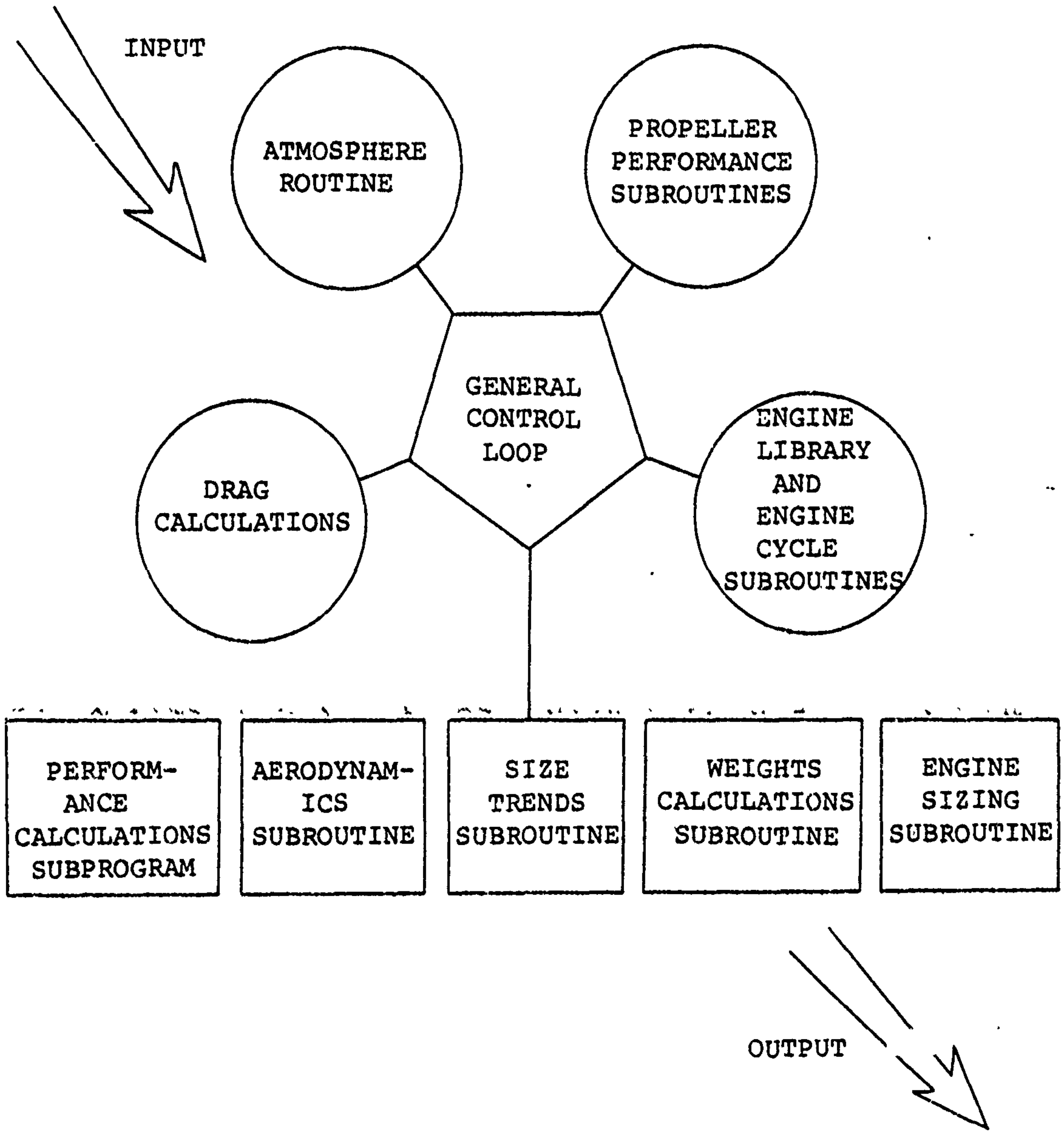


Figure 3-1. Sketch of Program Geometry.

TABLE 3-1
SUMMARY OF SUBROUTINES

ROUTINE	CALLED BY	PURPOSE
Main Control Loop	---	Monitor program operations, check convergence and calculate gross weight during iterative sizing option (OPTIND = 1)
Minor Subroutines:		
Drag Calculations	Performance Subroutines with SGTIND = 1-6, and Engine Sizing	Calculate airplane drag coefficient
Atmosphere	Performance subroutines with SGTIND = 1-6, Engine Sizing, and Size Trends	Calculate atmospheric density, pressure, temperature, and speed of sound
POWAVL	Performance subroutines with SGTIND = 1-6, Engine Sizing and Size Trends	Calculate power and fuel flow available for turboshaft engines by determining most critical operating restriction
POWREQ	Same as POWAVL	Calculate fuel flow for turboshaft engines when power required is less than power available.
ENG 1	POWREQ, POWAVL	Calculate power available for turboshaft engines at any specified turbine temperature including effects of Reynolds' number and operation at nonoptimum N_{II}

TABLE 3-1
(CONTINUED)

ROUTINE	CALLED BY	PURPOSE
THRAVL	Same as POWAVL	Calculate thrust and fuel flow available for turbofan and turbojet engines by determining most critical operating restriction
THRREQ	Same as POWAVL	Calculate fuel flow for turbofan and turbojet engines when thrust required is less than thrust available
LTHRAV	Taxi, Takeoff/Hover/Land, Engine Sizing, and Size Trends	Same as THRAVL except applies to lift engines
LTHREQ	Same as LTHRAV	Same as THRREQ except applies to lift engines
POWER	Performance subroutines with SCTIND = 2, 3, 4, & 6 and Engine Sizing and Size Trends	Calculate propeller power required when thrust and advance ratio are known
THRUST	Same as POWER	Calculate propeller thrust available when power and advance ratio are known
SCRIBE	Performance subroutines with SGTIND = 3, 4, 5, & 6.	Controls printout when detailed print option is desired (OPTIONAL PRINT INDICATOR = 1.0).

TABLE 3-1
(CONTINUED)

ROUTINE	CALLED BY	PURPOSE
<u>Major Subroutines</u>:		
Engine Sizing	Main	Calculates engine size (power or thrust) required to meet mission requirement
Weight Trends	Main	Calculates aircraft weight summary including propulsion, structures, flight controls and fuel available
Size Trends	Main	Calculates aircraft dimensions which are required for weight estimate and drag calculation
Aerodynamics	Main	Calculates lift curve slope, spanwise loading efficiency, and a series of coefficients which are used by the drag subroutine to calculate aircraft drag
<u>Major Subprogram</u>:		
Performance Calculations	Main	Monitors program flow during calculation of mission performance and calculates total fuel required at end of mission
<u>General Performance</u> Calculations	Performance Subprogram	Calculate power required, fuel flow, and other variables for given aircraft, starting at $V = 0$ to input V_{max}
<u>Performance Subroutines</u>:		
Taxi	Performance Subprogram	Calculate taxi performance
Takeoff, Hover, and Landing	Performance Subprogram	Calculate takeoff, hover, or landing performance

TABLE 3-1
(CONTINUED)

ROUTINE	CALLED BY	PURPOSE
Performance Subroutines (continued):		
Cruise	Performance Subprogram	Calculate cruise performance
Descent	Performance Subprogram	Calculate descent performance
Loiter	Performance Subprogram	Calculate loiter performance
Change Fuel Weight	Performance Subprogram	Add (or subtract) fuel to aircraft
Change Payload	Performance Subprogram	Add (or subtract) payload to aircraft
Transfer Altitude	Performance Subprogram	Changes altitude

3.4 SUBROUTINE CROSS REFERENCE

MAIN:

calls:	LOADER	SIZTR	AERO
	ENGSZ	WGHTR	LOADER
	ATMOS		

AERO

does not call any other subroutine

ATMOS

does not call any other subroutine

CHGPL

does not call any other subroutine

CHGFW

does not call any other subroutine

CLIMB

calls:	AERO	DRAG	POWAVL
	THRUST	THRAVL	DRAG
	POWER	POWREQ	THRREQ
	CRUS 1	CRUS 2	CRUS 3

CRUS 1

calls:	ATMOS	DRAG	POWER
	POWAVL	POWREQ	THRAVL
	THRREQ		

CRUS 2

calls:	ATMOS	DRAG	POWER
	POWAVL	POWREQ	THRAVL
	THRREQ	CRUS 1	

CRUS 3

calls:	ATMOS	DRAG	POWAVL
	POWER	THRAVL	POWREQ
	THRREQ		

DSCEX

calls:	ATMOS	DRAG	POWAVL
	THRAVL	THRREQ	POWREQ
	SCRIBE		

DSCNT

calls:	ATMOS	DRAG	POWAVL
	THRAVL	POWREQ	THRREQ
	SCRIBE		

ENGSZ

calls:	ATMOS	LIFAVL	DRAG
	THRAVL	POWAVL	THRUST

ENG1

does not call any other subroutine

LIFAVL

does not call any other subroutine

LOIT

calls:	ATMOS	DRAG	POWAVL
	POWER	POWREQ	THRAVL
	SCRIBE	THRREQ	

LIFREQ

does not call any other subroutine

PAYL

calls:	ENG 1	ENG 2

PLOTXY

calls: LOADER

POWER

calls:	POWAVL	POWREQ	THRUST

PRFRM

calls:	LOADER	TAXI	TOHL
	CLIMB	CRUS 1,3	DSCNT
	DSCEX	LOITER	CHGFW
	CHGPL	TRALT	PLOT XY

PRFRP

calls:	ATMOS	THRREQ	LIFAVL
	POWAVL	POWREQ	LIFREQ
	POWER	THRAVL	DRAG
	CRUS 1, 3	LOITR	

SCRIBE

calls:	POWAVL	POWREQ	THRAVL

SIZTR

calls:	ATMOS	POWAVL	THRUST
	THRAVL	LIFAVL	

THRAVL

calls: does not call any other subroutine

TAXI

calls:	ATMOS	THRAVL	THRAVL
	POWAVL	LIFAVL	

THRUST

does not call any other subroutine

TOHL

calls:	ATMOS	POWAVL	POWER
	THRREQ	POWREQ	THRAVL
	LIFAVL	LIFREQ	THRUST

TRALT

calls:	CRUS 1	CRUS 2	CRUS 3

THRREQ

does not call any other subroutine

WGHTR

does not call any other subroutine

4.0 DETAILED PROGRAM DESCRIPTION

4.0 MAIN CONTROL LOOP

Figure 4-1 is a flow chart of the main control loop for the computer program. For aircraft weights and size data only (OPTIND = 0), the user inputs a gross weight and some preliminary aircraft dimensions. The program will not iterate the weights and size, and no performance data will be printed out. In the sizing routine (OPTIND = 1), the program iterates on the aircraft gross weight until the fuel available and the fuel required are equivalent within a specified tolerance. If OPTIND = 2 or 3, the program bypasses the size trends, engine sizing, and weight trends subroutines. If OPTIND = 3, the program iterates to determine the takeoff weight and fuel required to fly a specified mission.

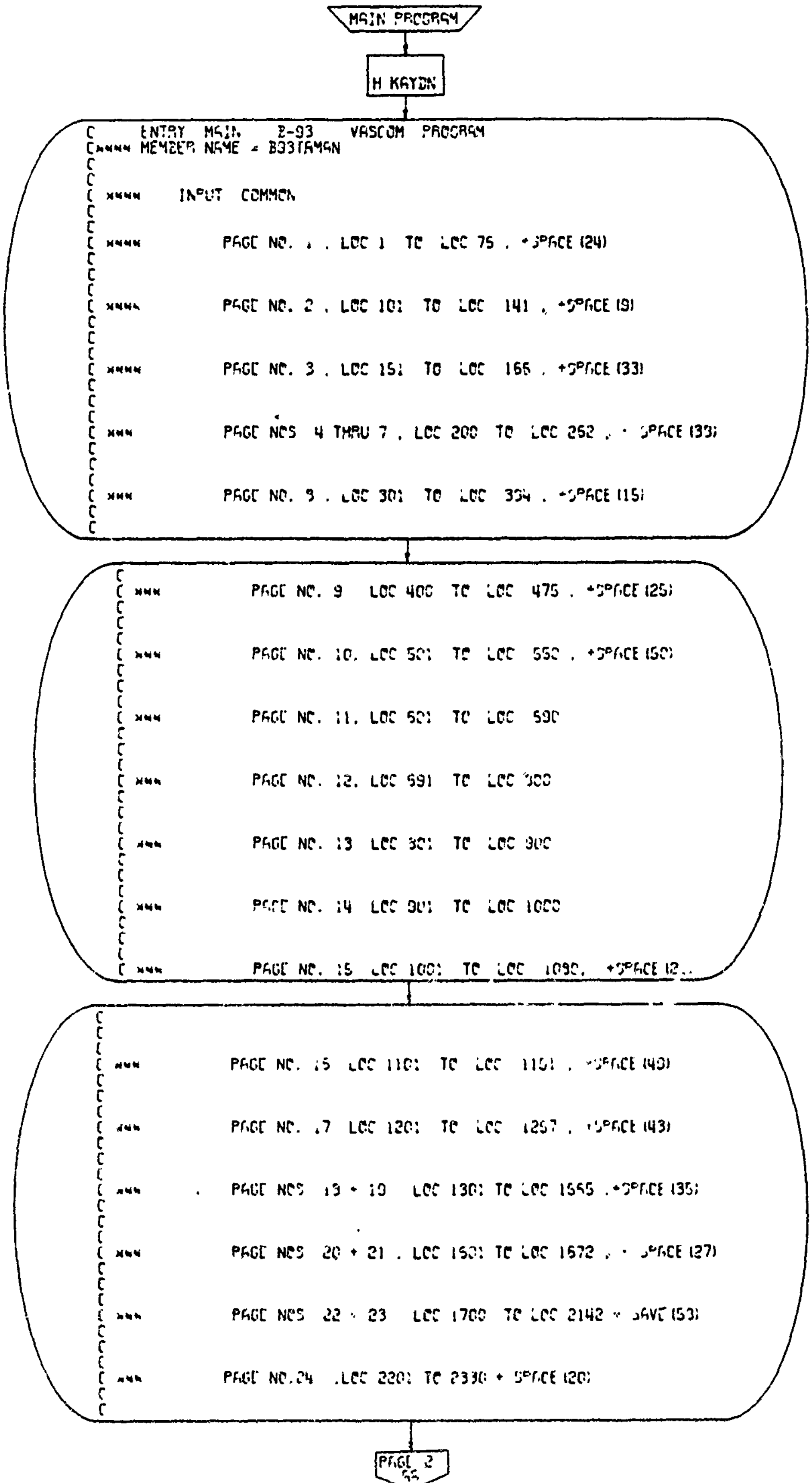


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Figure 4-1. Main Control Loop, Flow Chart (Part 1 of 25)

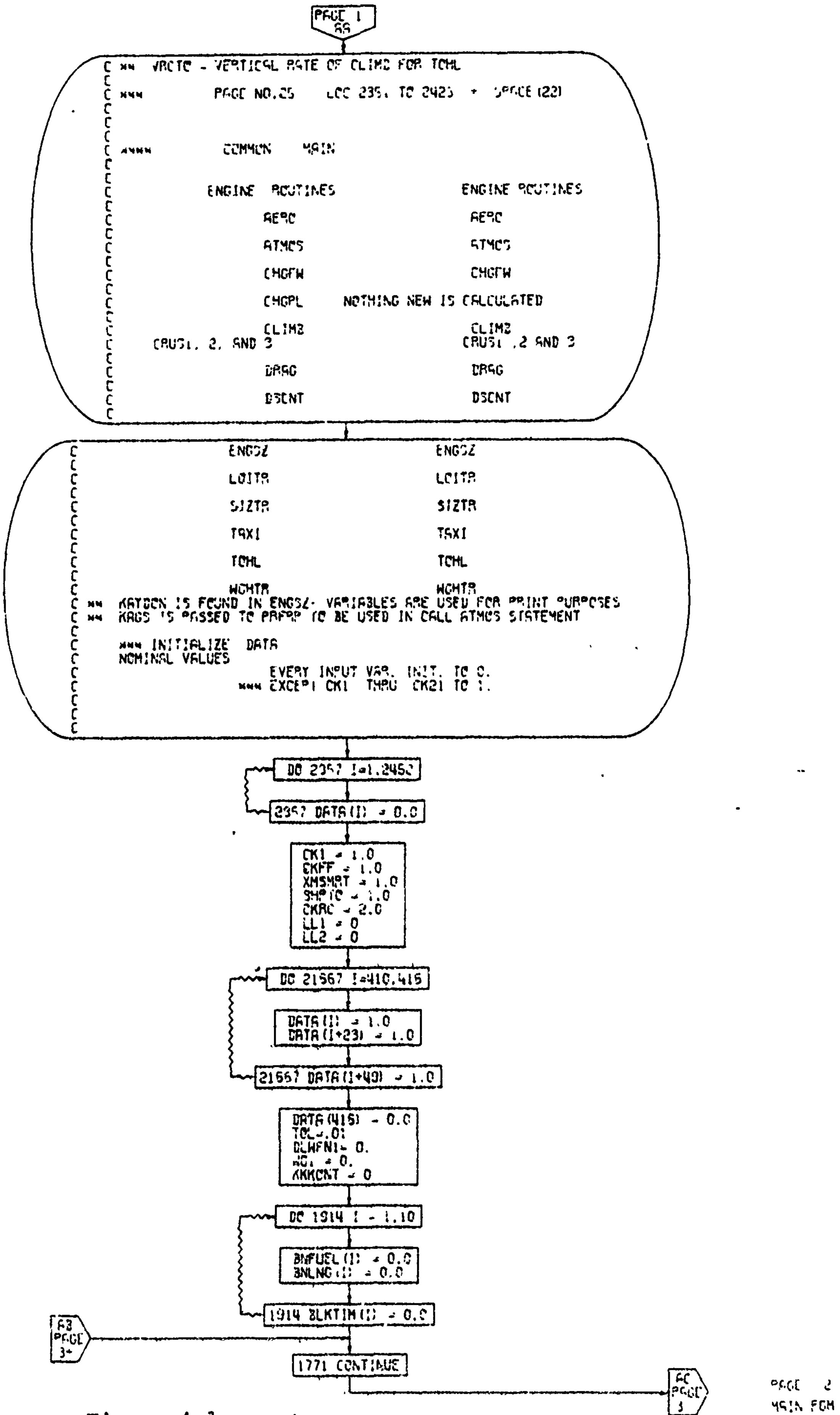

Figure 4-1. Main Control Loop, Flow Chart
(Part 2 of 25)

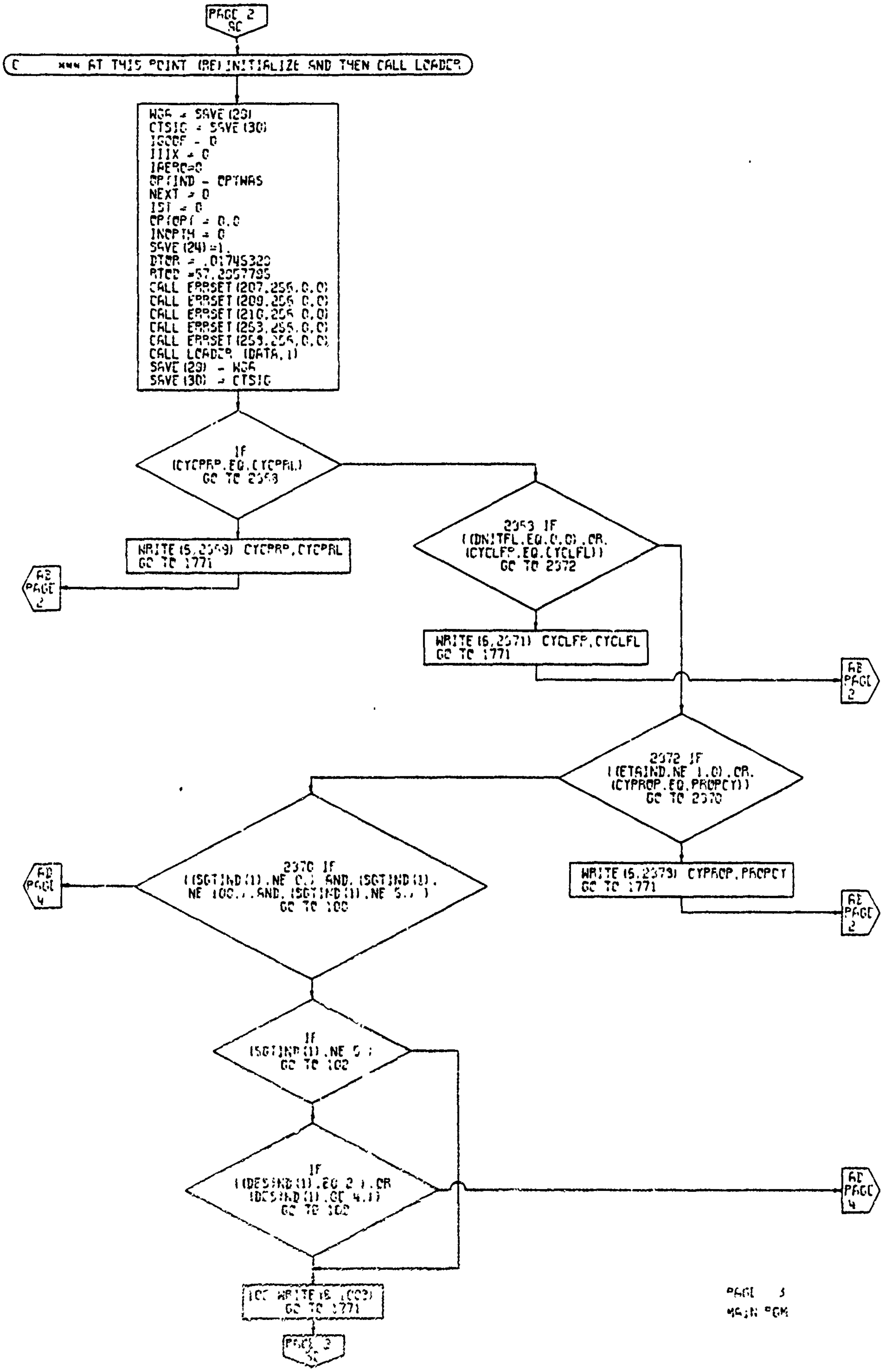

Figure 4-1. Main Control Loop, Flow Chart
(Part 3 of 25)

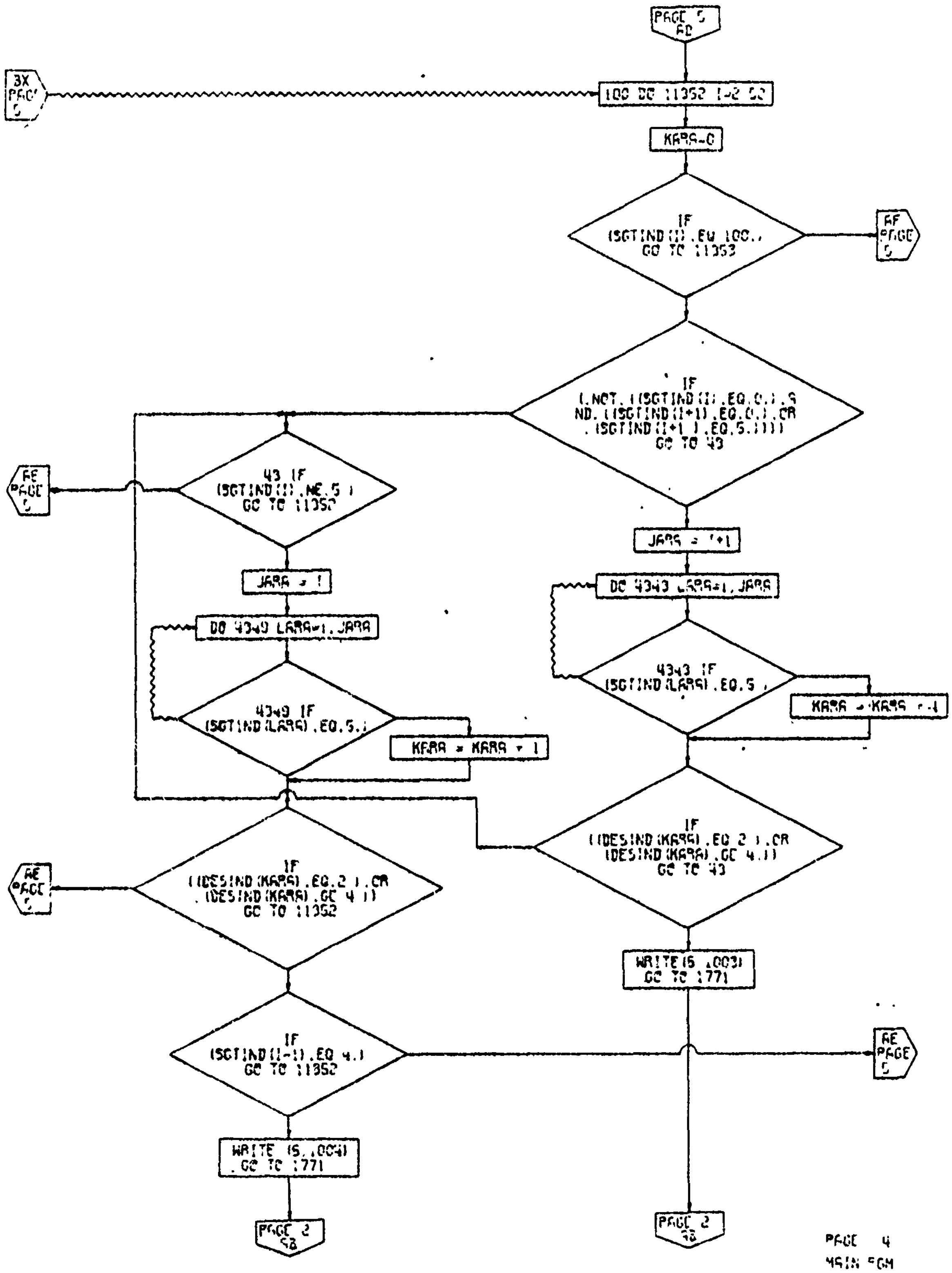

Figure 4-1. Main Control Loop, Flow Chart (Part 4 of 25)

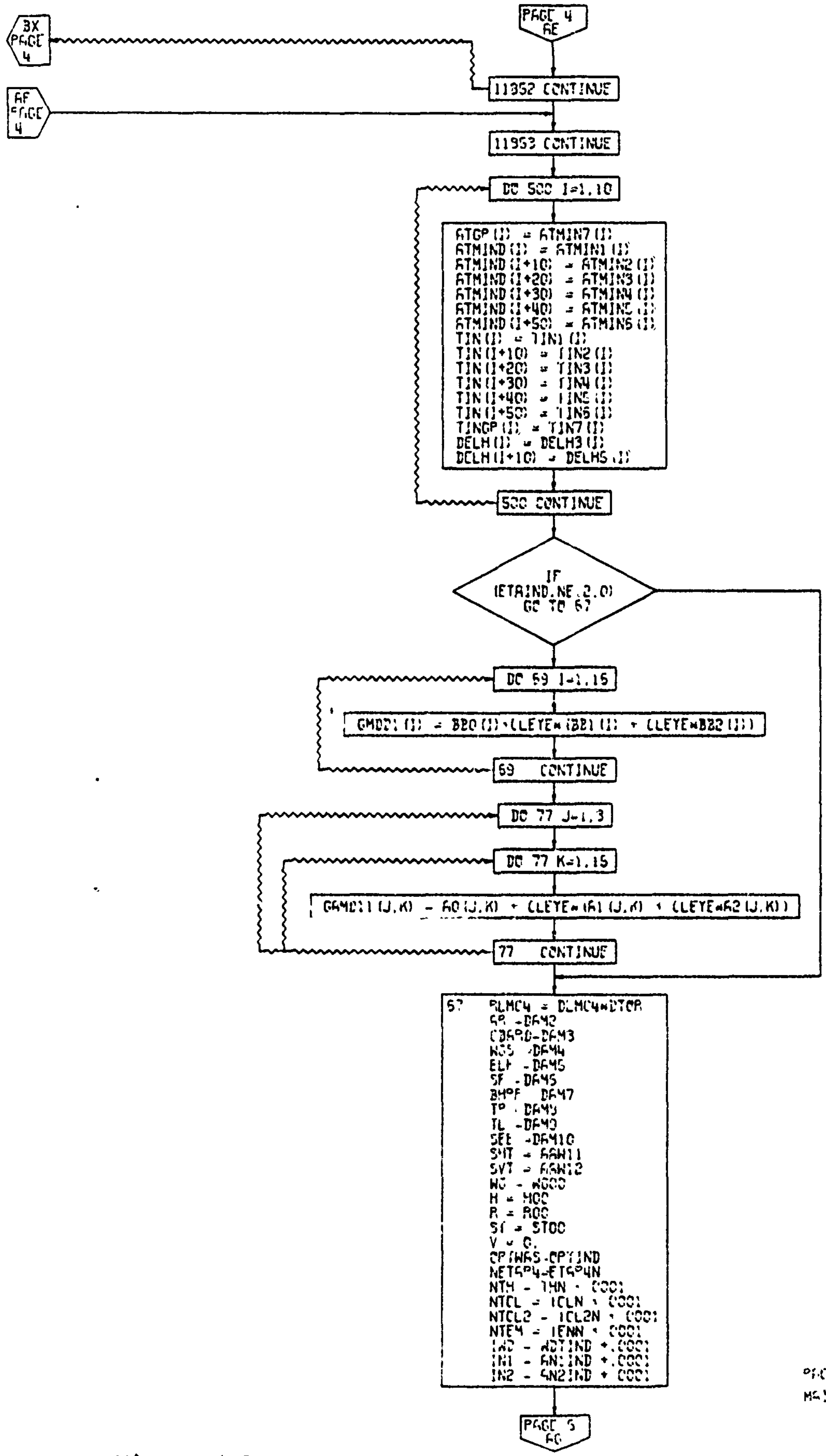

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Figure 4-1. Main Control Loop, Flow Chart
(Part 5 of 25)

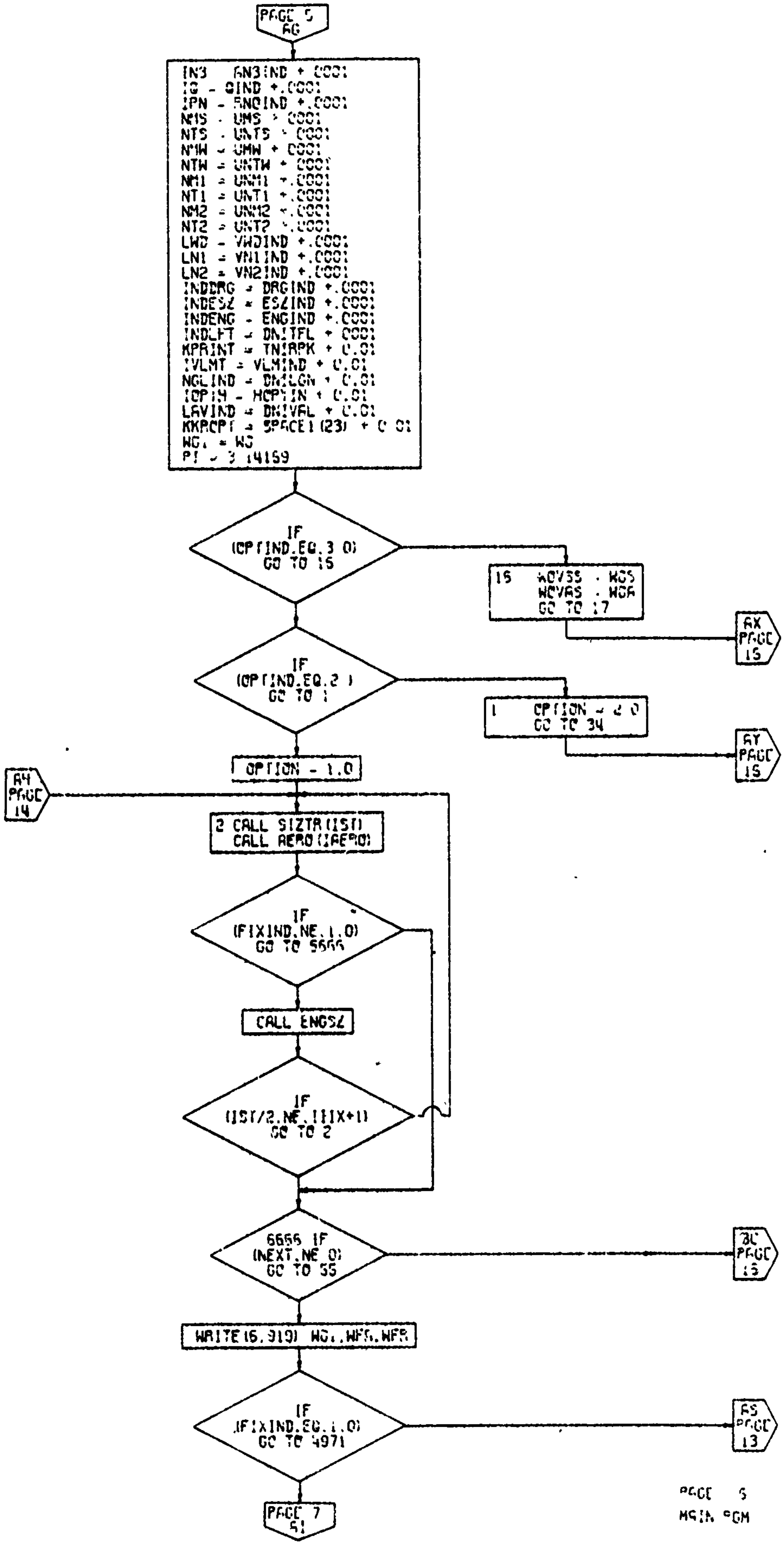


Figure 4-1. Main Control Loop, Flow Chart
(Part 6 of 25)

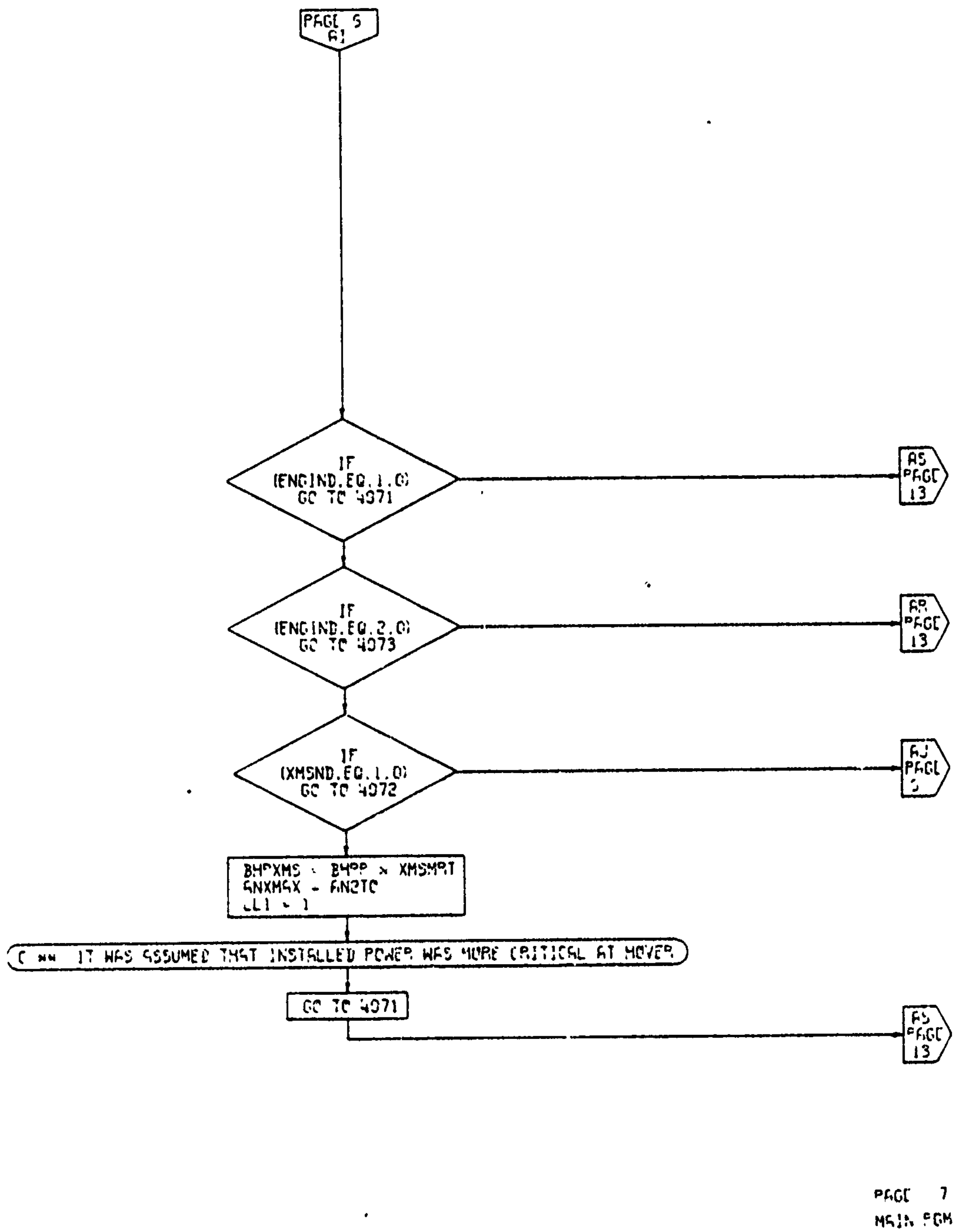


Figure 4-1. Main Control Loop, Flow Chart
(Part 7 of 25)

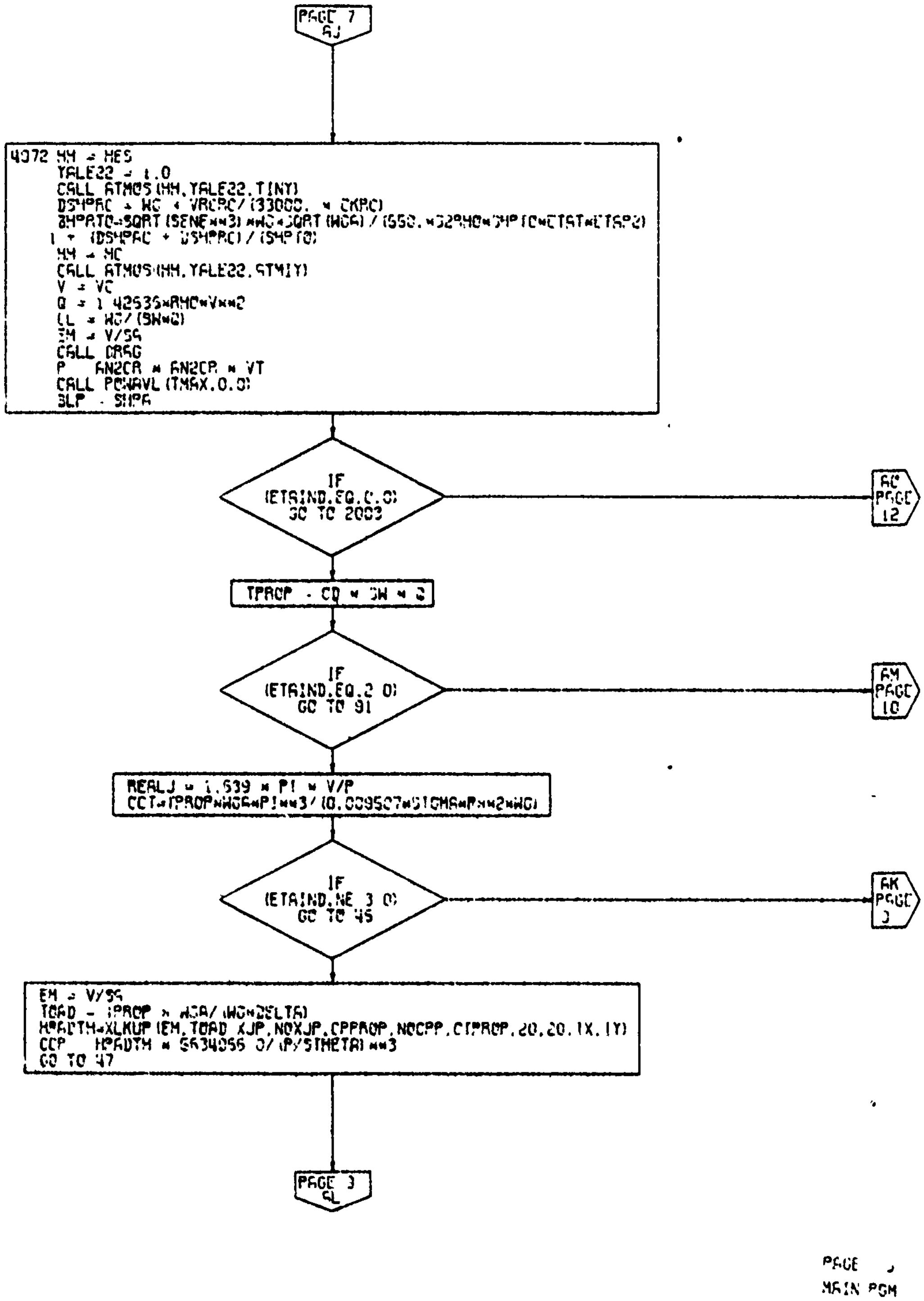


Figure 4-1. Main Control Loop, Flow Chart
(Part 8 of 25)

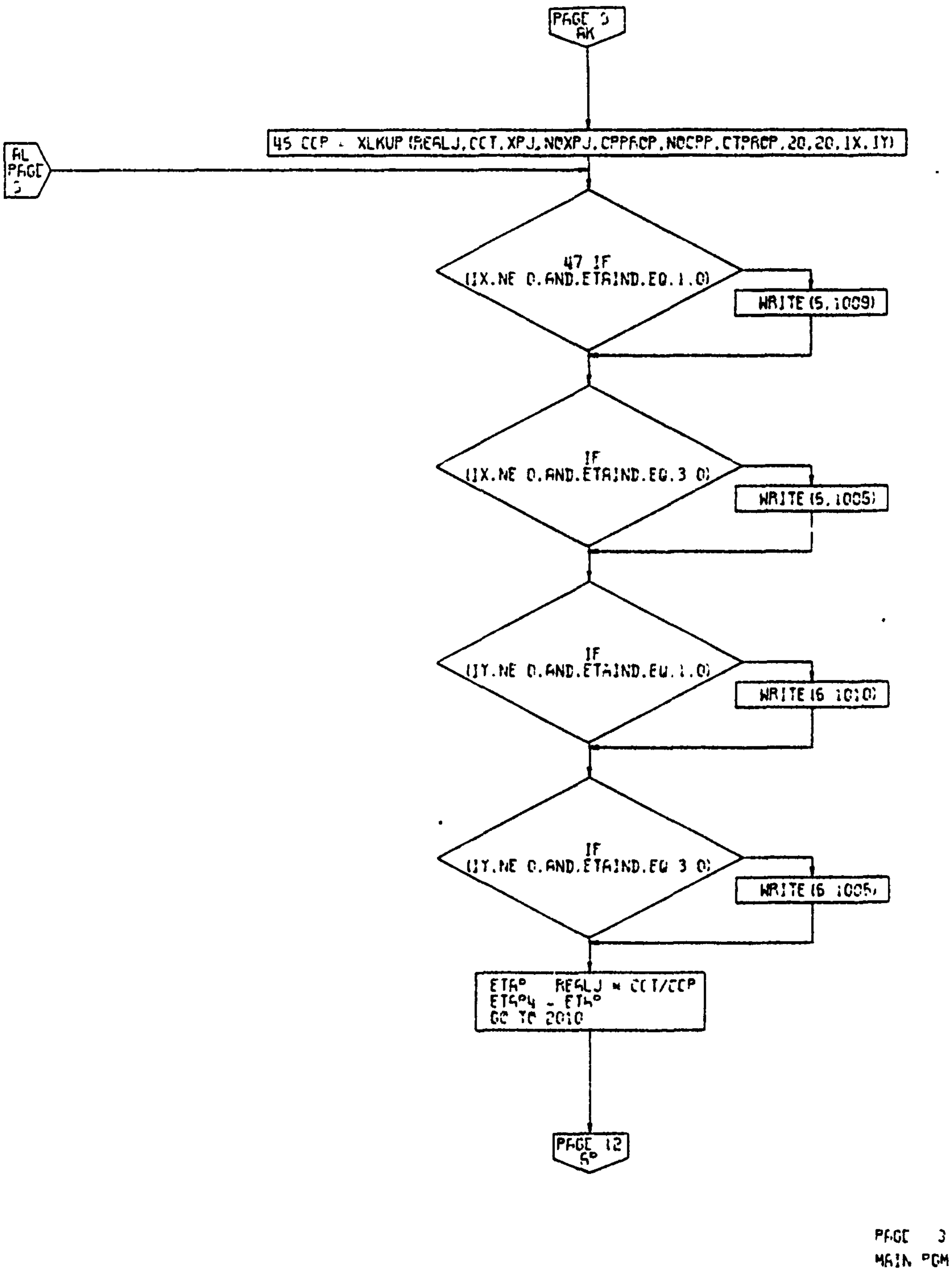
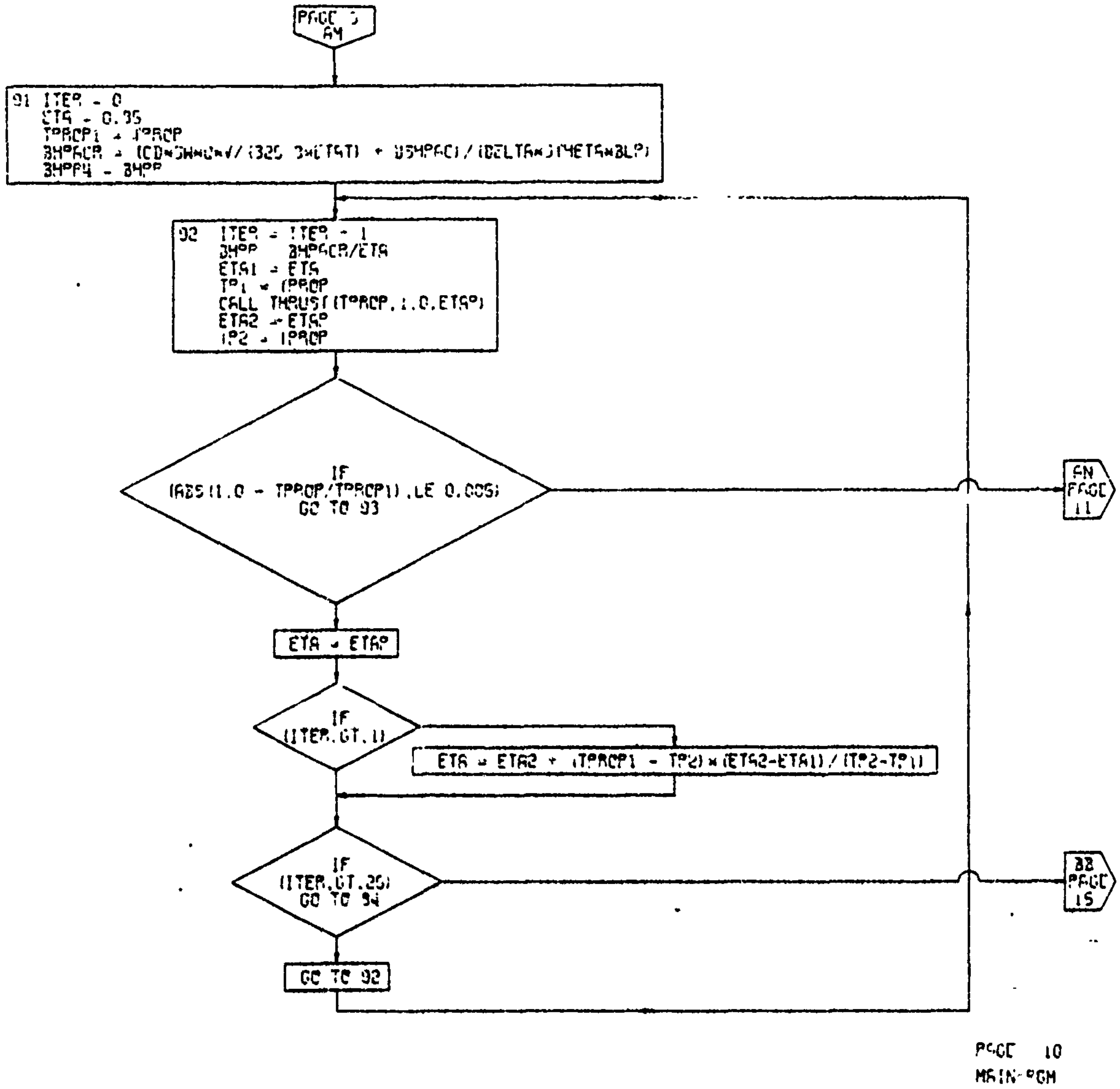


Figure 4-1. Main Control Loop, Flow Chart
(Part 9 of 25)



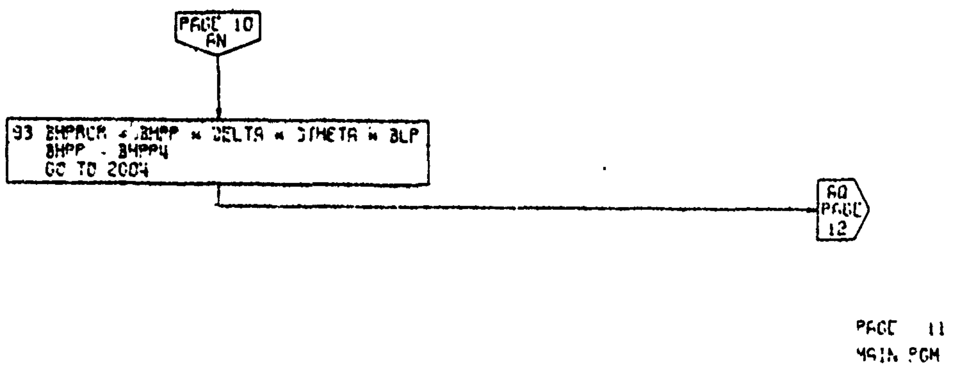


Figure 4-1. Main Control Loop, Flow Chart
(Part 10 of 25)

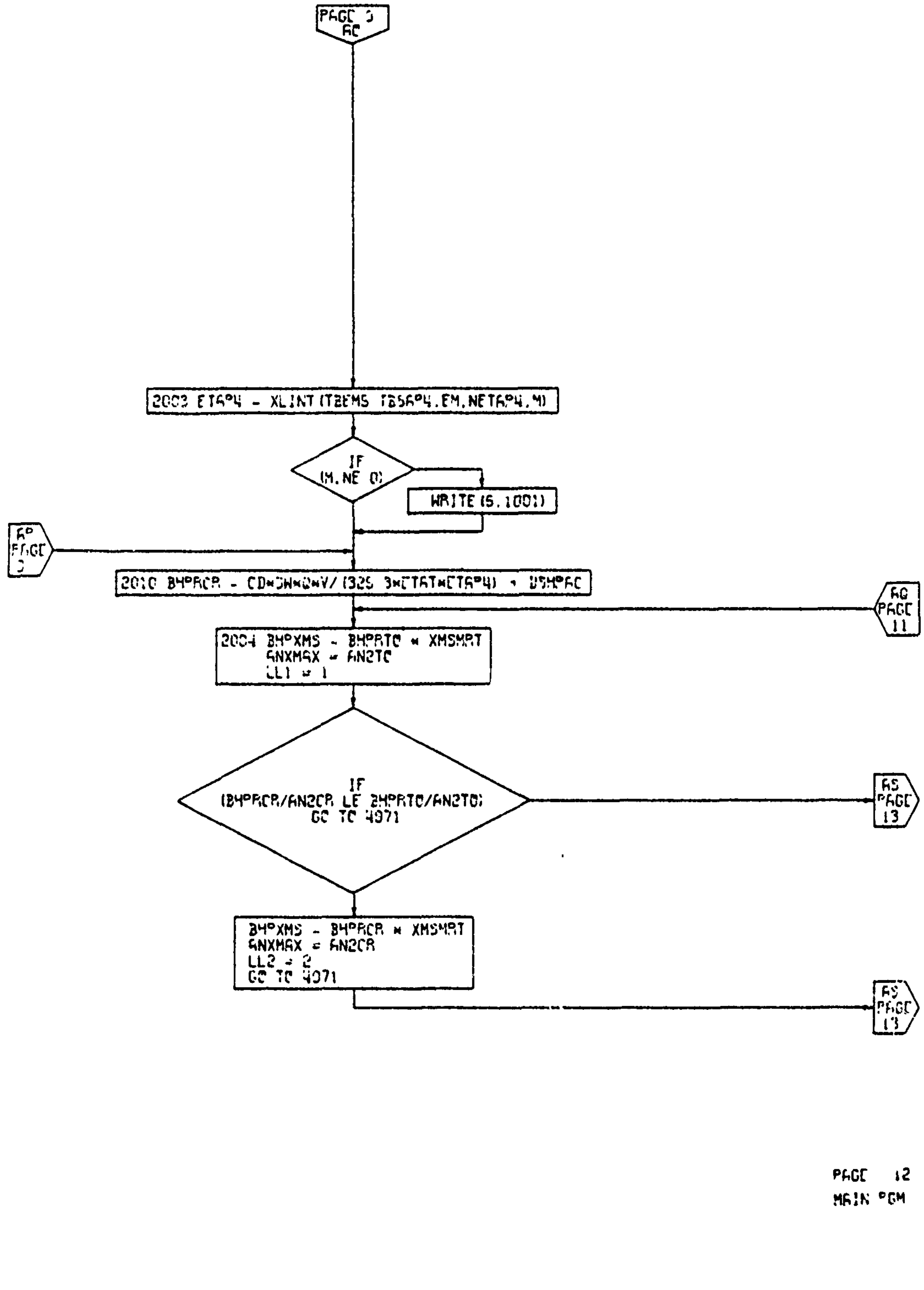


Figure 4-1. Main Control Loop, Flow Chart
(Part 11 of 25)

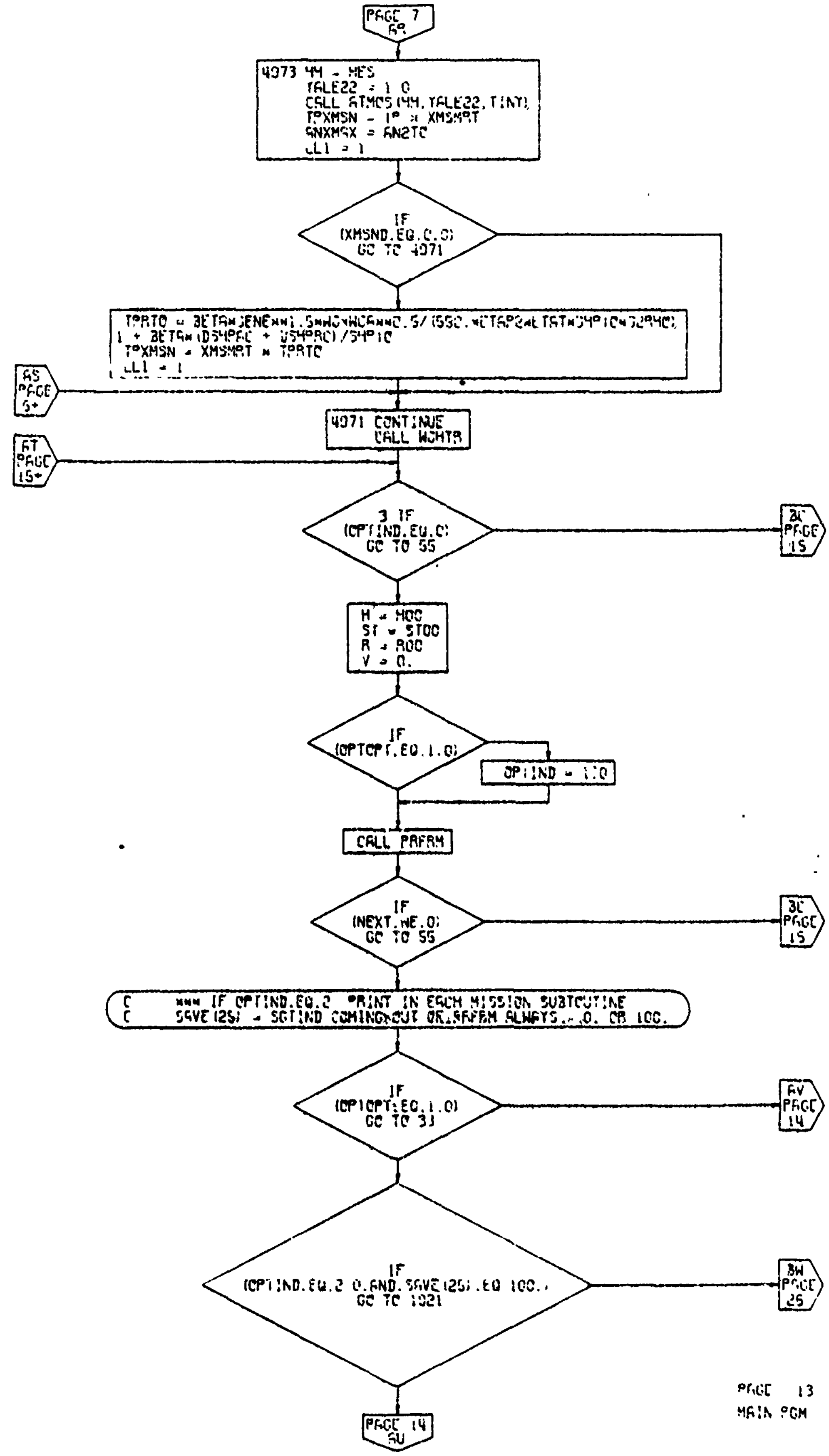


Figure 4-1. Main Control Loop, Flow Chart (Part 12 of 25)

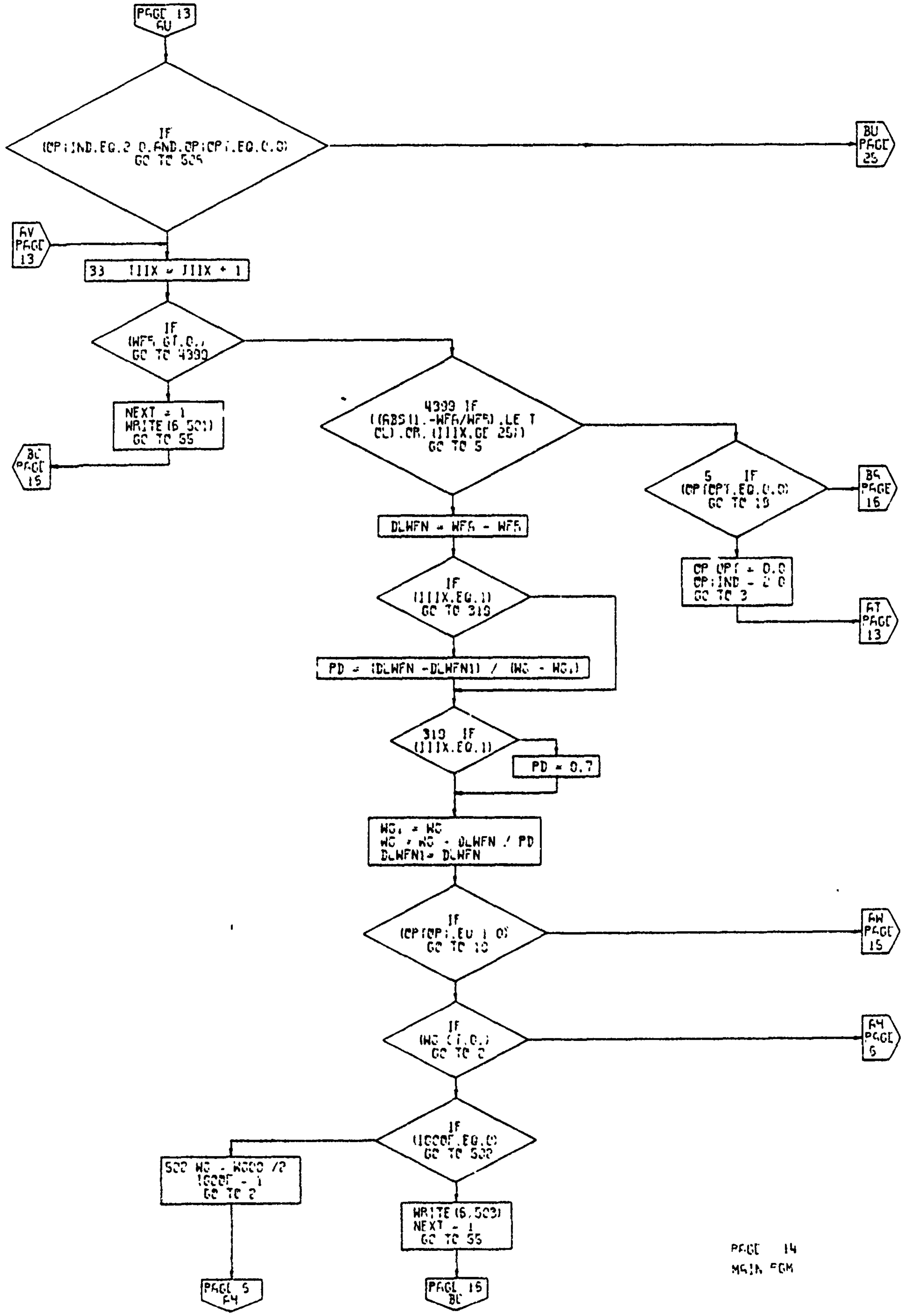
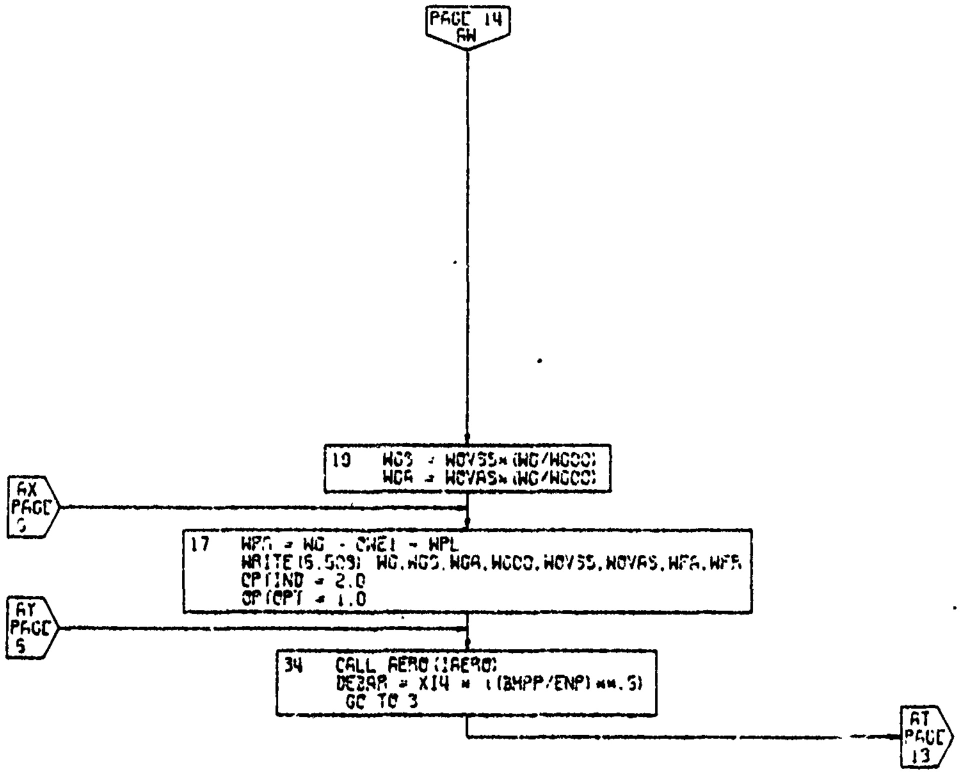


Figure 4-1. Main Control Loop, Flow Chart
(Part 13 of 25)



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MAIN PGM

Figure 4-1. Main Control Loop, Flow Chart
(Part 14 of 25)

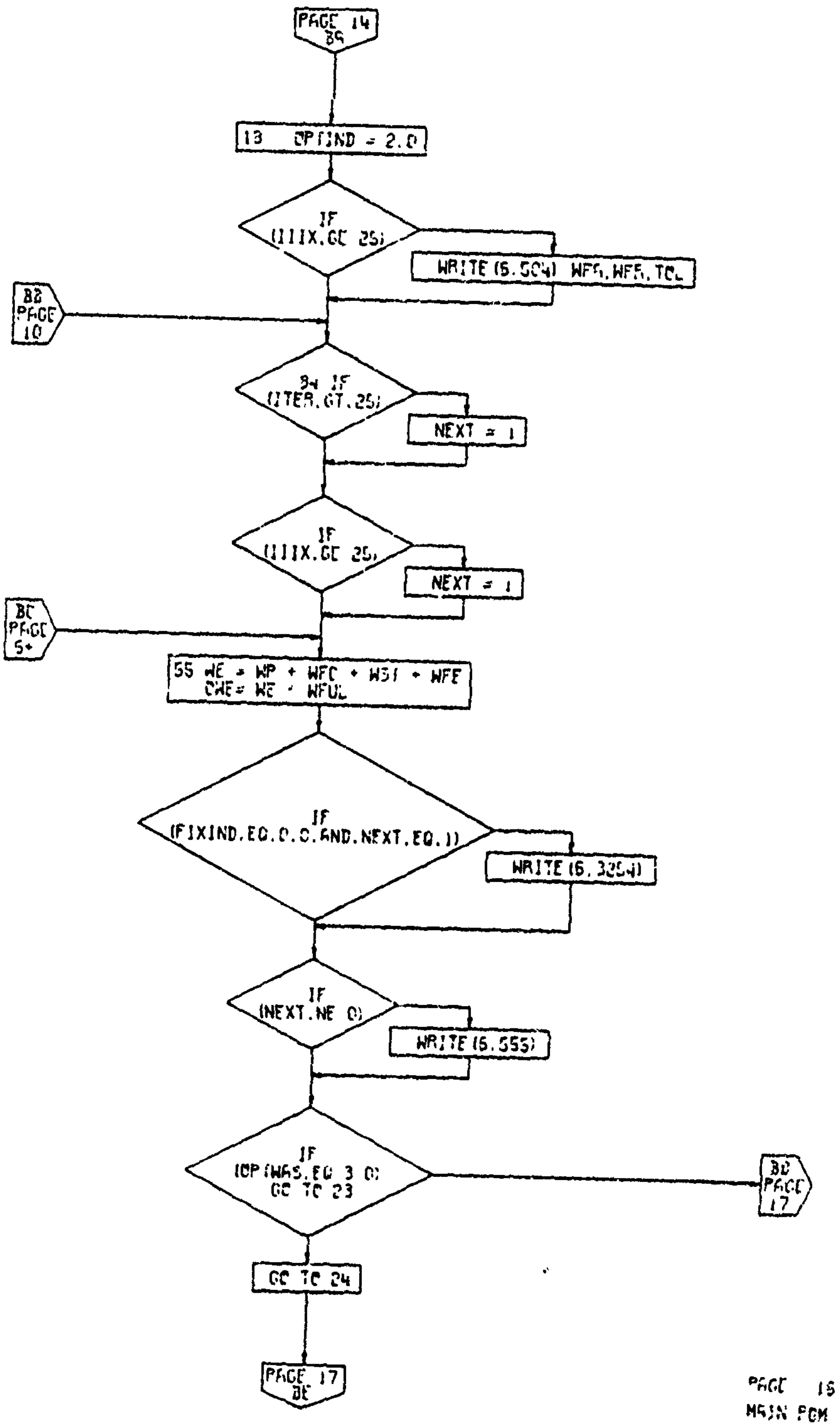


Figure 4-1. Main Control Loop, Flow Chart
(Part 15 of 25)

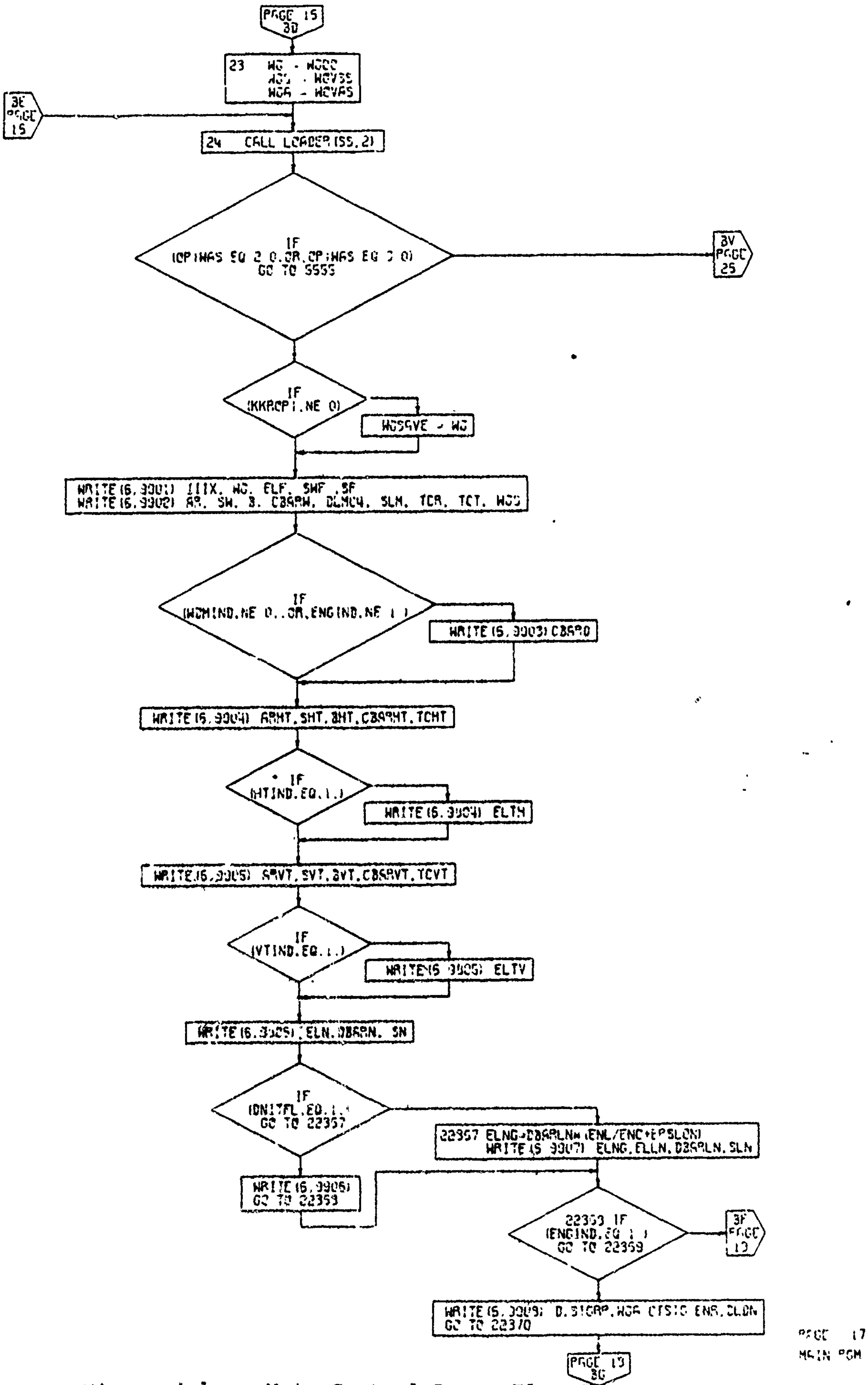
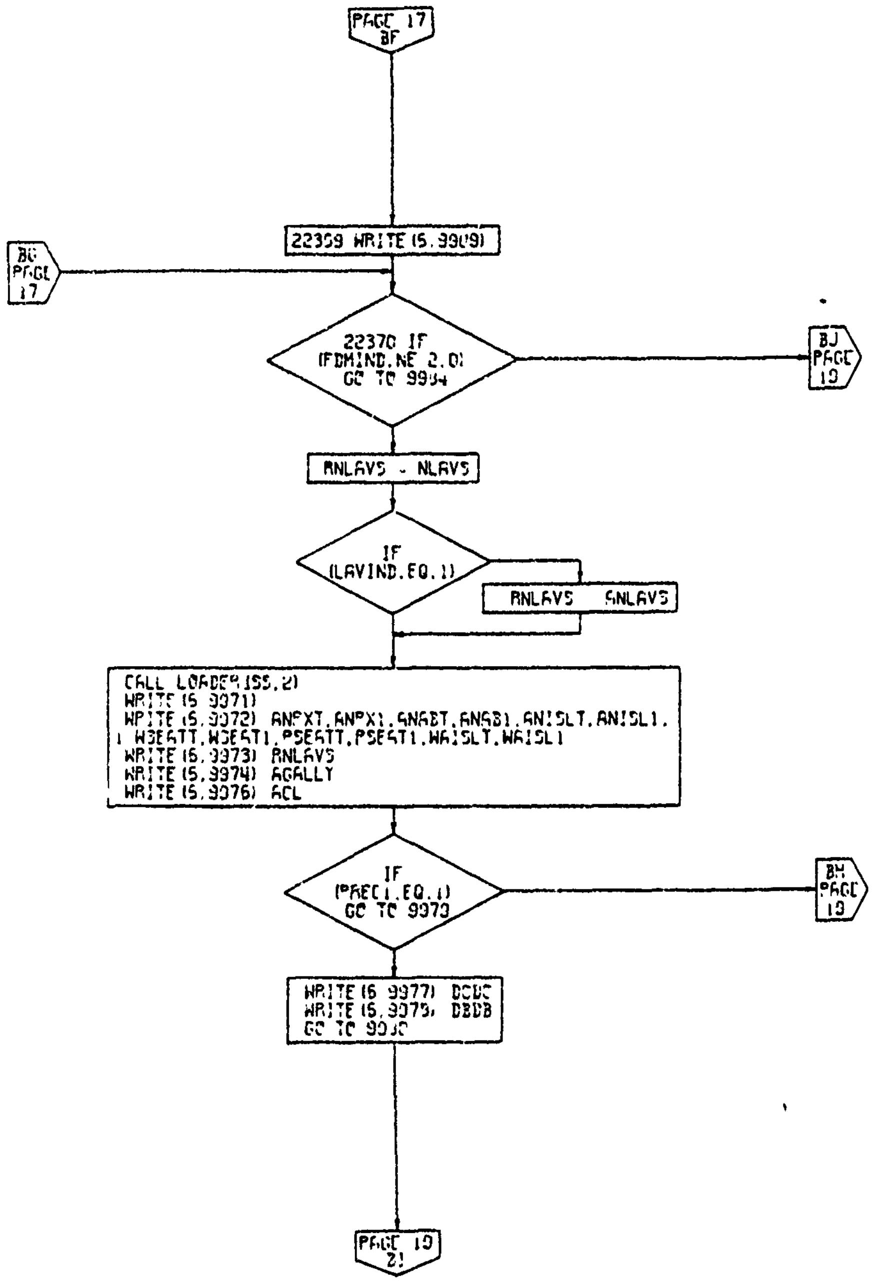


Figure 4-1. Main Control Loop, Flow Chart (Part 16 of 25)



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MAIN PGM

Figure 4-1. Main Control Loop, Flow Chart
(Part 17 of 25)

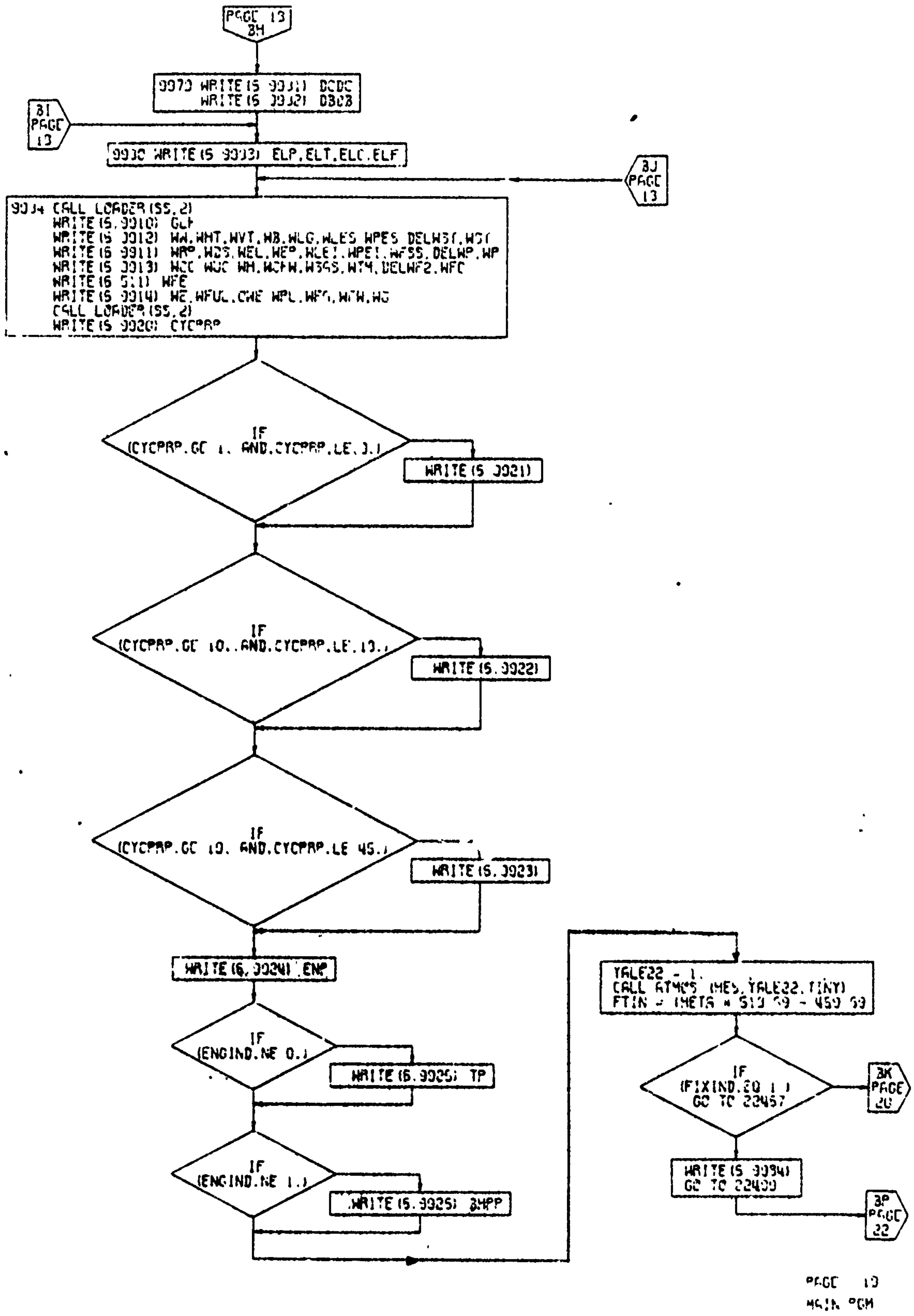


Figure 4-1. Main Control Loop, Flow Chart
(Part 18 of 25)

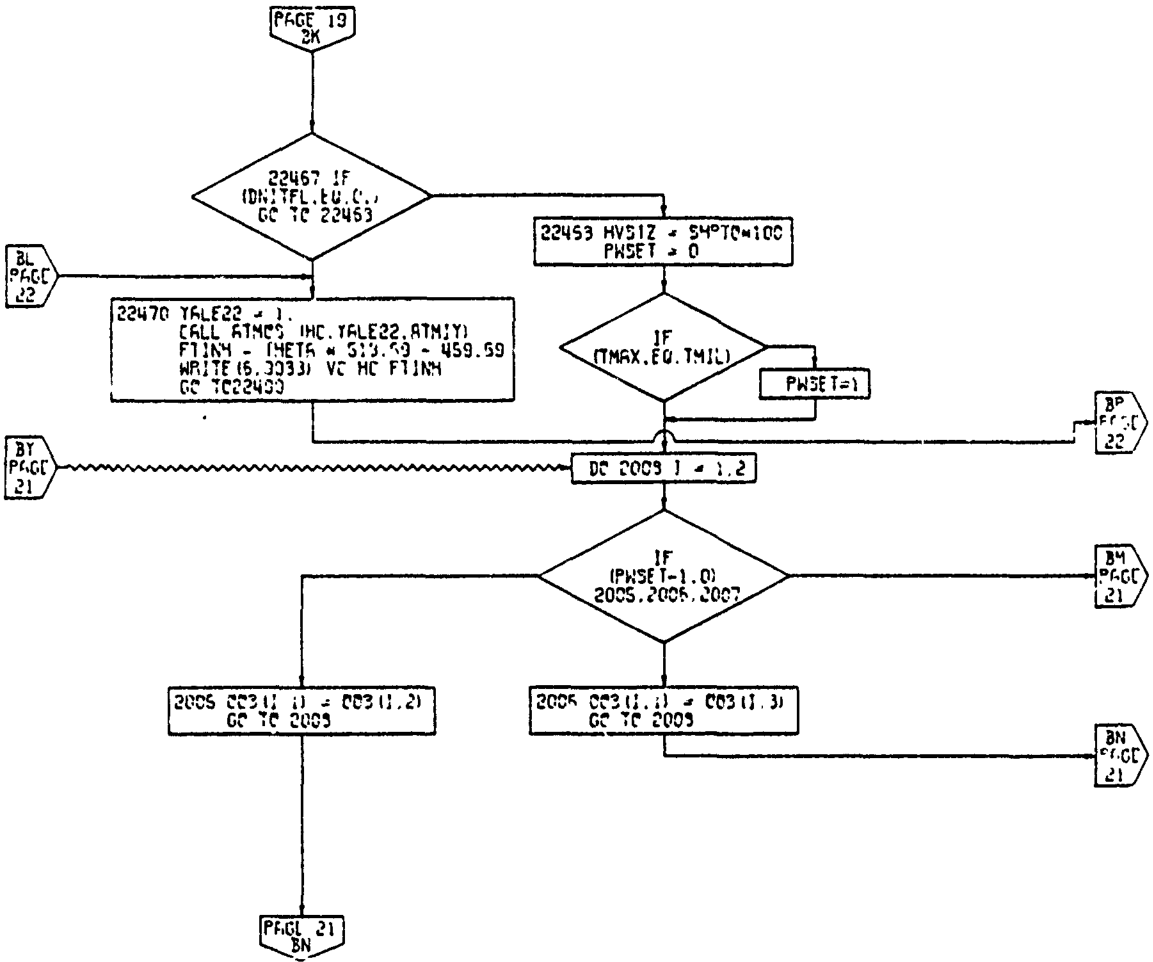


Figure 4-1. Main Control Loop, Flow Chart
(Part 19 of 25)

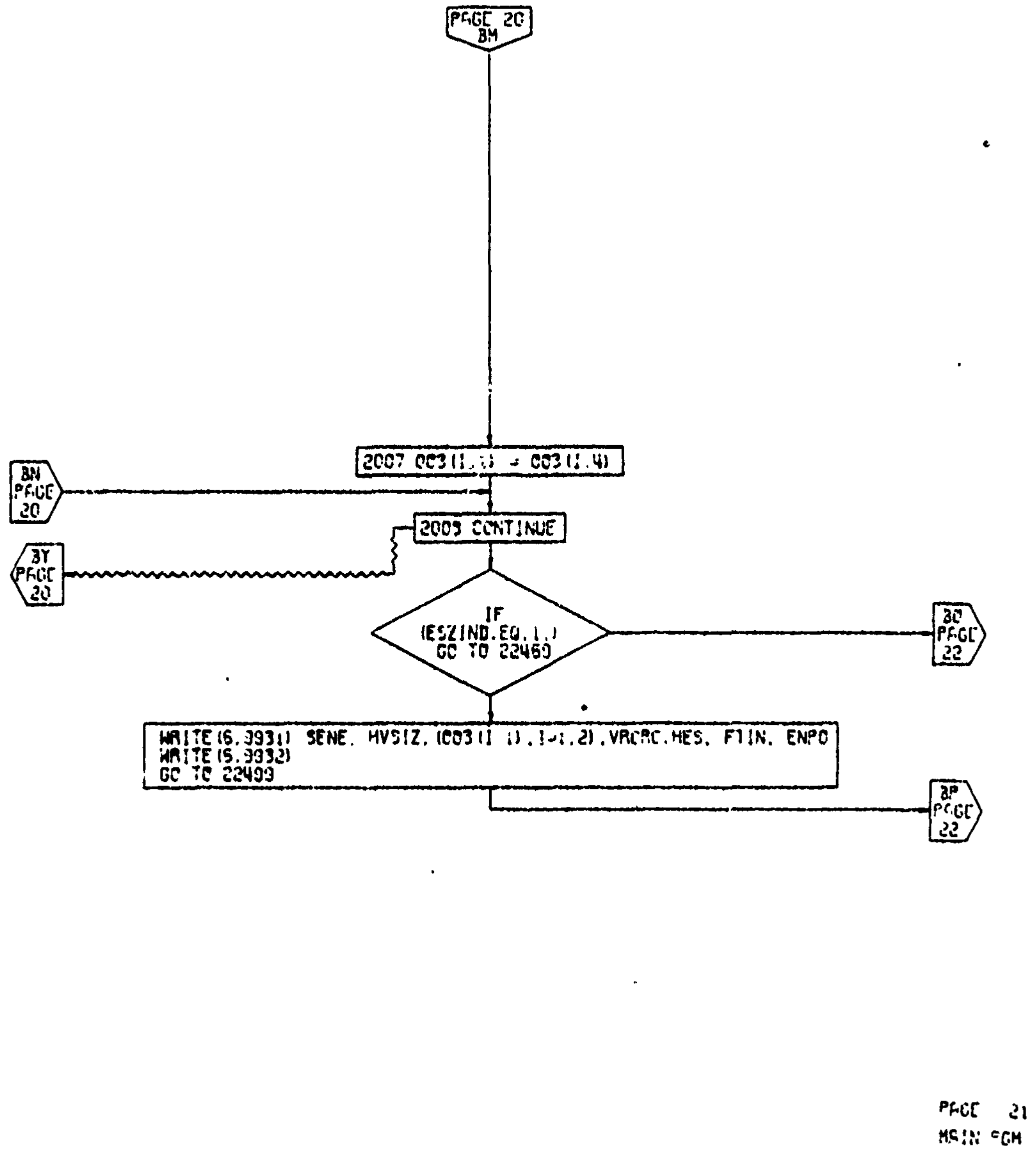


Figure 4-1. Main Control Loop, Flow Chart
(Part 20 of 25)

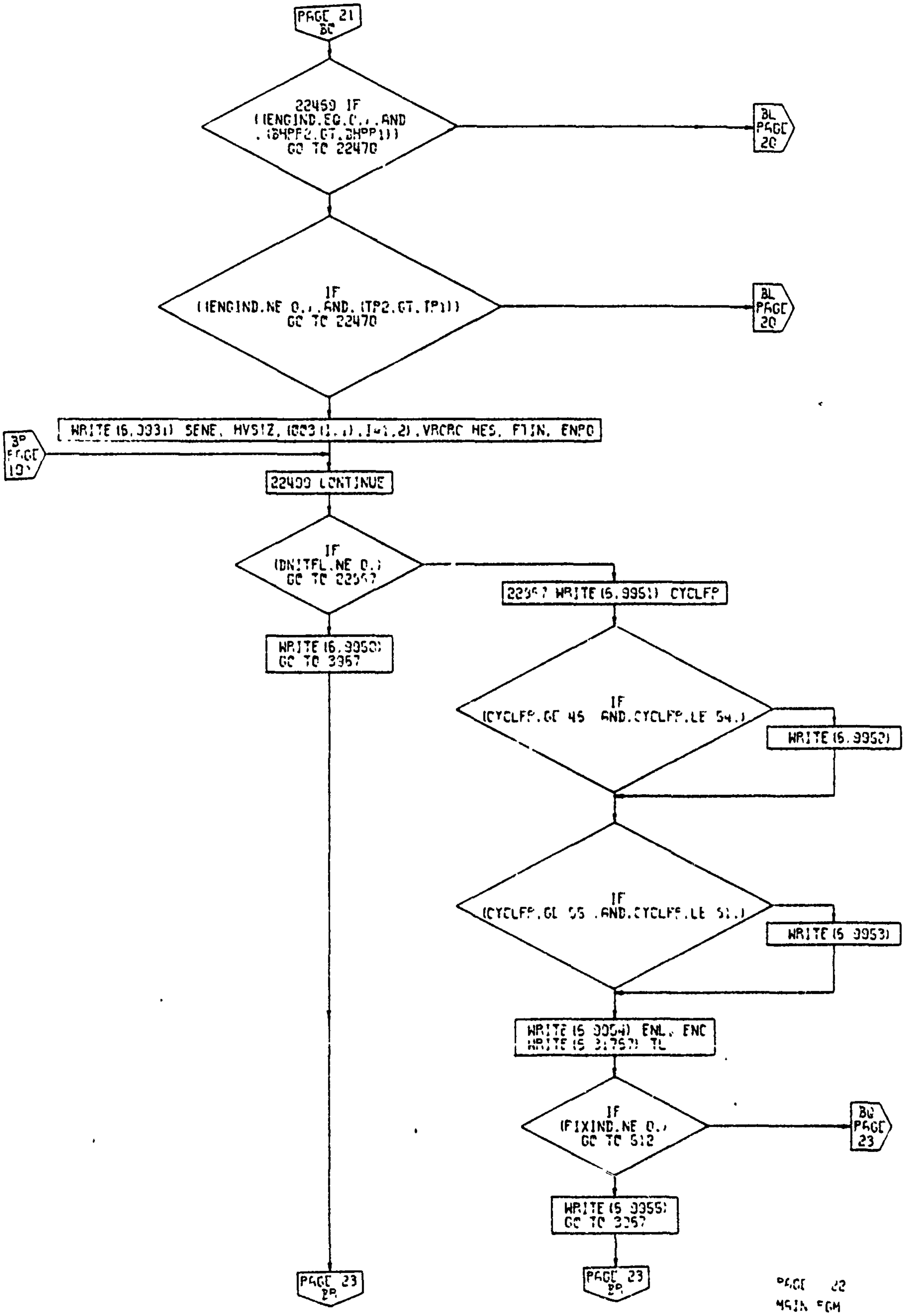


Figure 4-1. Main Control Loop, Flow Chart (Part 21 of 25)

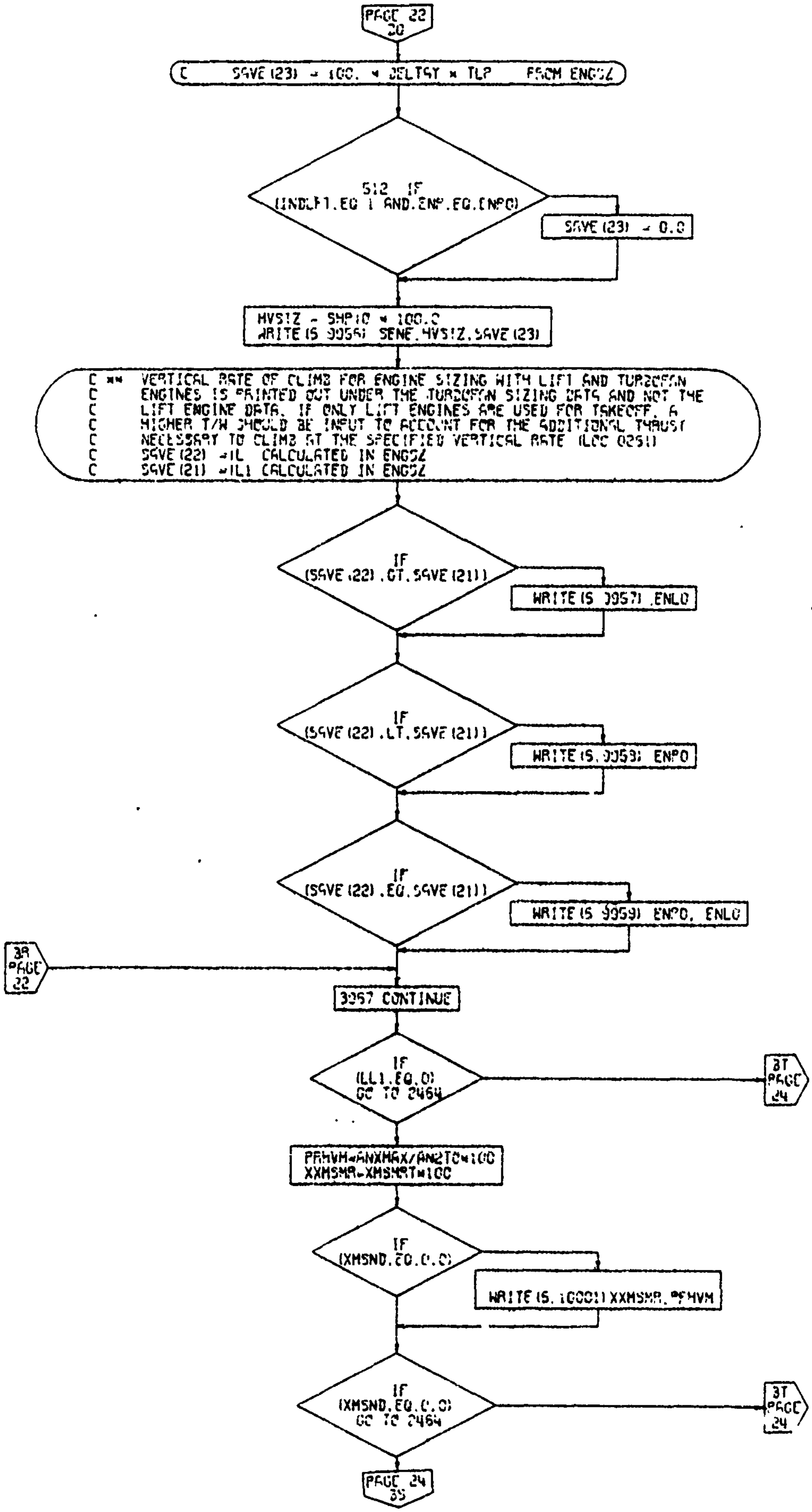


Figure 4-1. Main Control Loop, Flow Chart (Part 22 of 25)

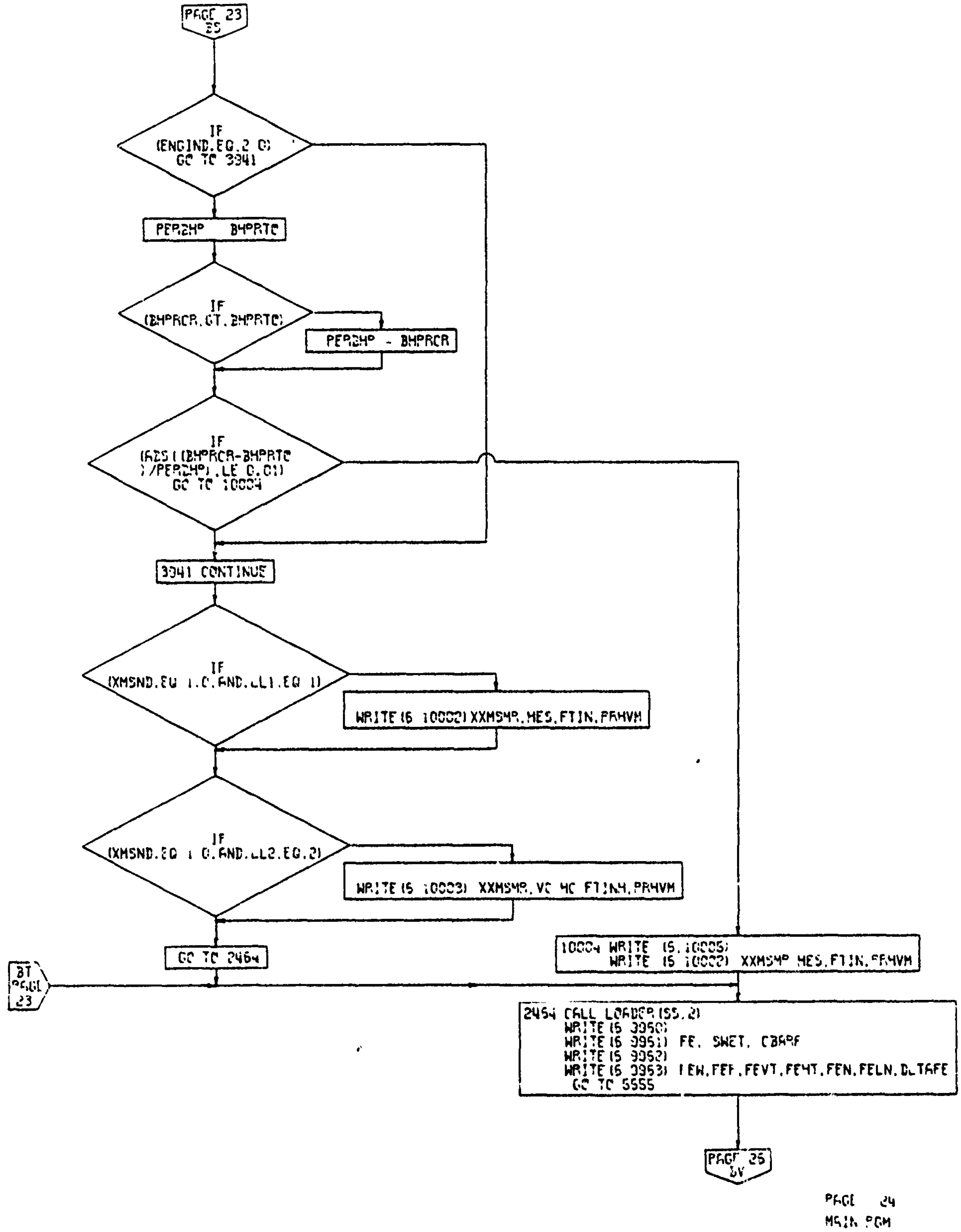


Figure 4-1. Main Control Loop, Flow Chart (Part 23 of 25)

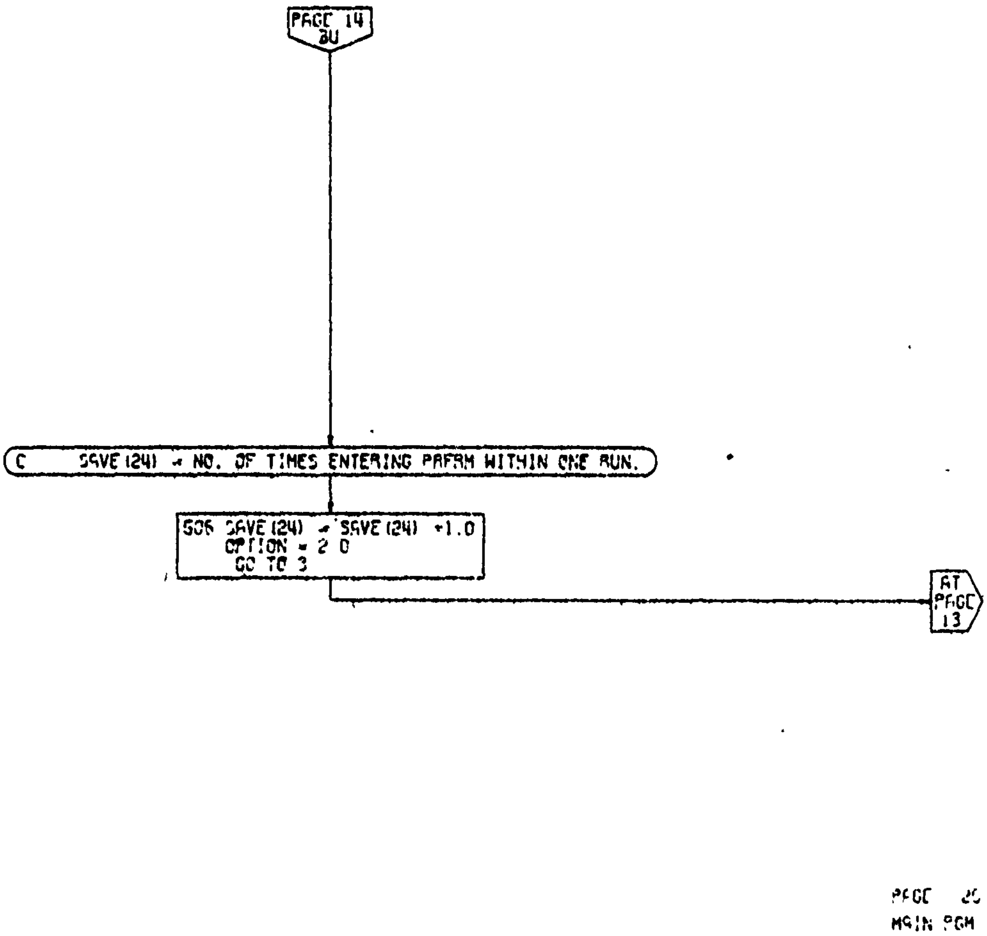


Figure 4-1. Main Control Loop, Flow Chart
(Part 24 of 25)

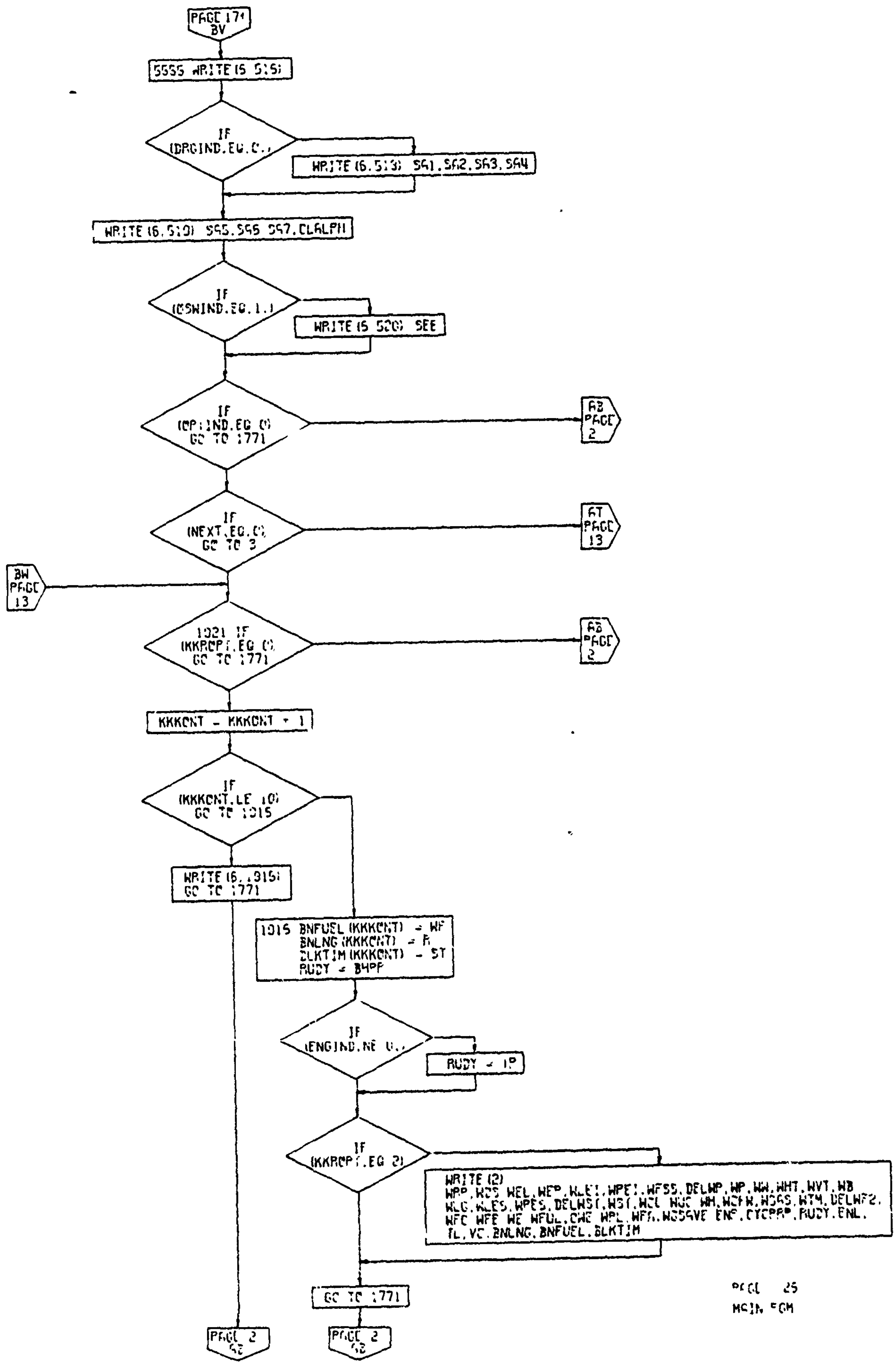


Figure 4-1. Main Control Loop, Flow Chart
(Part 25 of 25)

4.2 ATMOSPHERE SUBROUTINE

The atmosphere subroutine will calculate the atmospheric density, pressure, and temperature as a function of altitude. Three options included below are available. These are specified by means of an input indicator, ATMIND, which is input individually for the performance data and the engine sizing data. Thus, the atmosphere can be calculated differently for each segment of the flight profile and for the engine sizing.

The options are:

ATMIND = 0: Standard atmosphere

ATMIND = 1: Constant increment in temperature above standard temperature

ATMIND = 2: Nonstandard temperature distribution as a function of altitude

The flow chart for the atmosphere subroutine is shown in Figure 4-2.

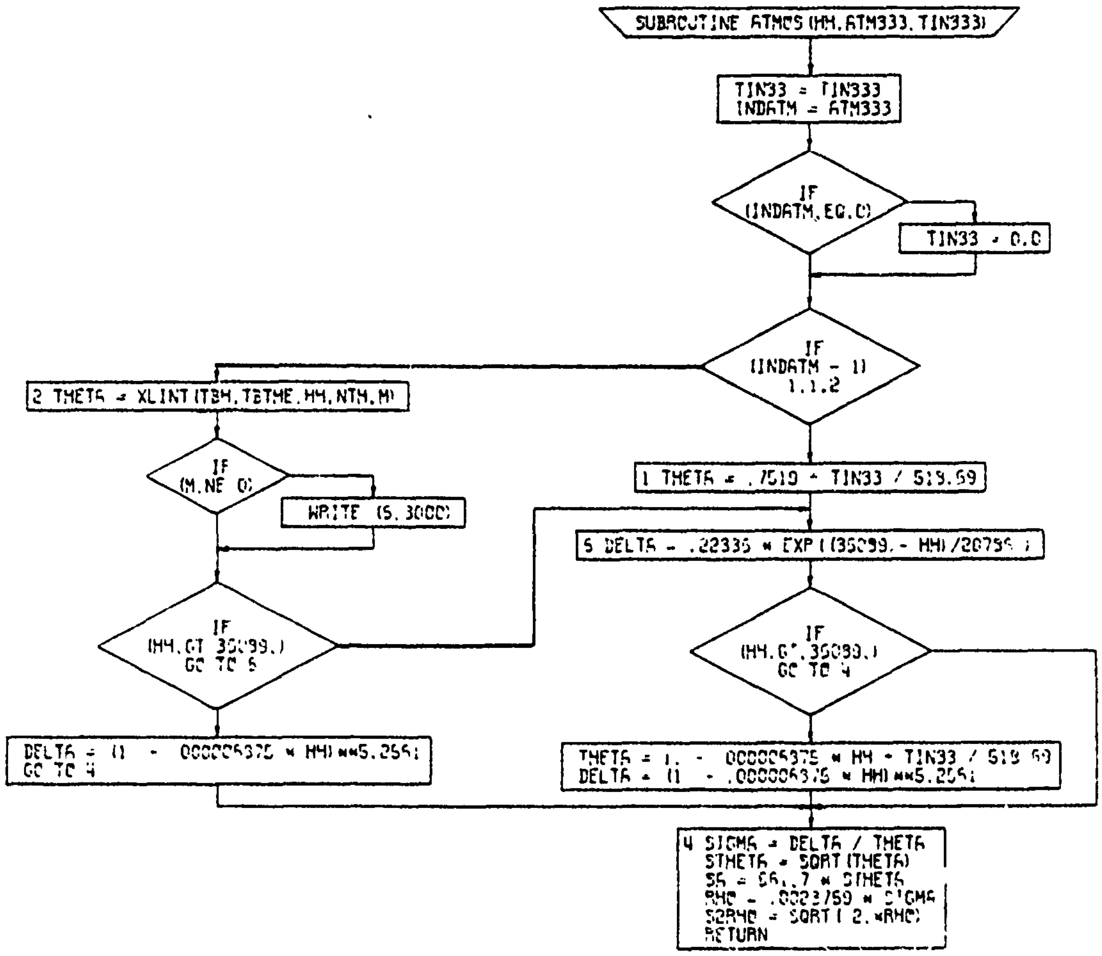


Figure 4-2. Atmosphere Subroutine, Flow Chart

4.3 DRAG CALCULATIONS SUBROUTINE

The drag calculations subroutine uses the factors a_1 through a_7, as determined by the aerodynamics calculations subroutine, to calculate the drag of the airplane (see Section 4.7). Aircraft C_D is calculated as a function of C_L and Mach number. Since the calculation of compressibility drag is based upon a semi-empirical technique, it is limited in accuracy to a specific Mach number range. For analysis of aircraft flying at Mach numbers beyond that range, a calculation option is provided. By setting a drag indicator (DRGIND) equal to unity, a tabular compressibility drag (function of C_L and M) may be used. This option requires preparation and input of a three-dimensional table. The subroutine flow chart is shown in Figure 4-3.

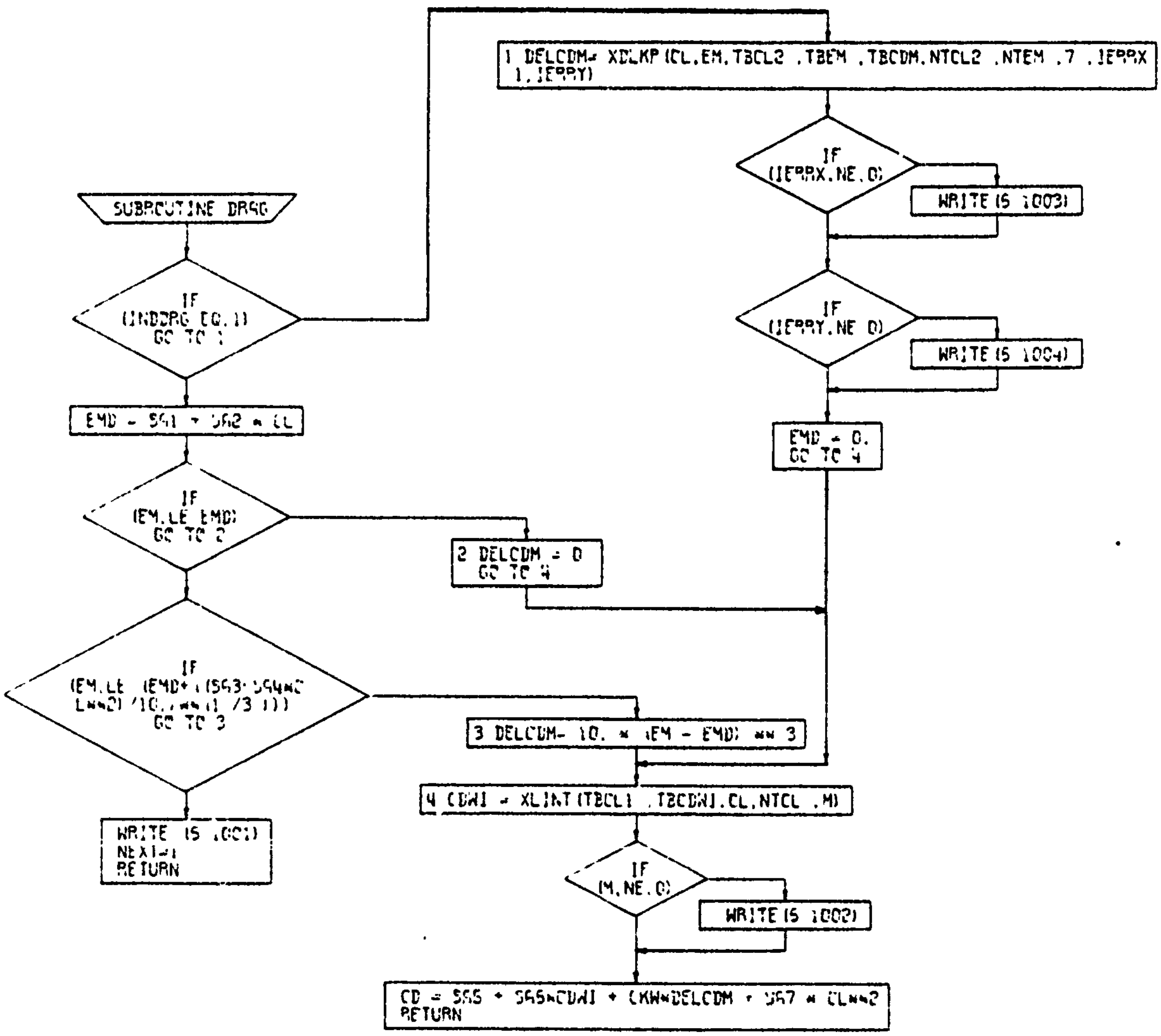


Figure 4-3. Drag Calculations Subroutine, Flow Chart

4.4 ENGINE LIBRARY AND ENGINE CYCLE SUBROUTINES

The basic cycle performance data consists of tabulated values of four variables:

1. referred thrust or horsepower

   $F_N/\delta F_N{}^*$ or $SHP/\delta\sqrt{\theta}\ SHP^*$

   input locations 1326-1373

2. referred fuel flow

   $W_f\ /\delta\sqrt{\theta}F_N{}^*$ or $W_f/\delta\sqrt{\theta}\ SHP^*$

   input locations 1390-1437

3. referred gas generator shaft RPM

   $N_I\ /\sqrt{\theta}\ N_I{}^*$

   input locations 1454-1501

4. referred power turbine shaft RPM

   $N_{II}/\sqrt{\theta}\ N_{II}{}^*$

   input locations 1518-1565

For the primary engine cycles, these tables are functions of Mach number and referred turbine inlet temperature. For lift engine cycles, the tables are functions only of referred turbine inlet temperature. All data are in referred, normalized format as shown in Table 4-1.

The standard engine cycle library consists of forty-five different generalized engine cycles shown in Table 4-2. The data for each cycle is punched in card form, accessible for input with the remainder of the input data for a given case. Each cycle is numbered; and, to guard against selection of an incorrect cycle, the cycle number is checked against a similar number input to the program by the user.

The fuel flow of the basic engine cycle should correspond to the manufacturer's specification data. Adjustments to the fuel flow level may be made by means of the input multiplier, K_{FF}.

Because of the normalized, referred format, all data are valid for any ambient temperature, standard or nonstandard. With the exception of referred power, none of the tables are dependent upon power turbine speed. Usually $\dfrac{N_{II}}{N_{II_{OPT}}}$ Loc (1238), is set equal to 1.0 in order to determine $\dfrac{N_{II}}{N_{II_{MAX}}}$ through the relationship

Table 4.1 Engine Cycle Data Format

VARIABLE	SYMBOL	REFERRED, NORMALIZED FORM
Thrust	F_N	$F_N/\delta F_N^*$
Power	SHP	$SHP/\delta\sqrt{\theta}SHP^*$
Gas Generator rpm	N_I	$N_I/\sqrt{\theta}N_I^*$
Power Turbine rpm	N_{II}	$N_{II}/\sqrt{\theta}N_{II}^*$
Fuel Flow	$\dot{W}_f$	$\dot{W}_f/\delta\sqrt{\theta}F_N^*$ $\dot{W}_f/\delta\sqrt{\theta}SHP^*$
Turbine Inlet Temperature	T	T/θ
Where:	* =	Max. Power Setting, Static, Sea Level, Standard Day
	θ =	Ambient Temperature (°R) Divided by 518.69°R
	δ =	Ambient Pressure (psia) Divided by 14.696 psia

$$\frac{N_{II}}{N_{II_{OPT}}} = 1.0 = \frac{\left(\frac{N_{II}}{N_{II_{MAX}}}\right)\left(\frac{N_{IIMAX}}{N_{II}^*}\right)}{\left(N_{II_{OPT}}/N_{II}^*\sqrt{\theta}\right)} \quad \frac{1}{\sqrt{\theta}}$$

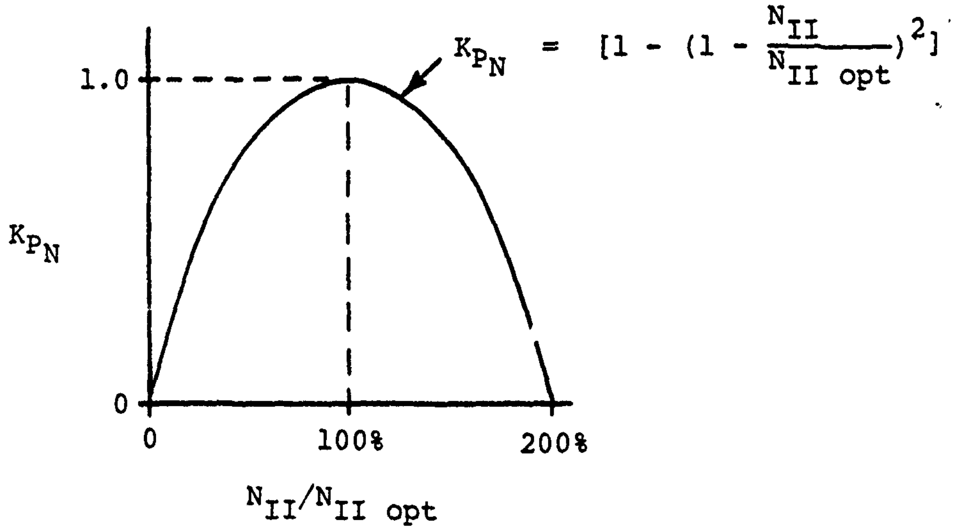
where $\frac{N_{IIMAX}}{N_{II}^*}$ is input into Loc (1223). If $\frac{N_{II}}{N_{II_{MAX}}}$ is determined to be an unsatisfactory value, greater than 1.0, then set $\frac{N_{II}}{N_{II_{MAX}}} = 1.0$ for specific segment and calculate $\frac{N_{II}}{N_{II_{OPT}}}$. Changes in $\frac{N_{II}}{N_{II_{OPT}}}$ directly affect $\frac{N_{II}}{N_{II_{MAX}}}$ and indirectly affect operating tip speed through

$$V_T \text{ operating} = \left(\frac{N_{II}}{N_{II_{MAX}}}\right)\left(\frac{N_{II_{MAX}}}{N_{II}^*}\right) V_T$$

		Engine Cycle Number	Max. Turbine Inlet Temperature - °R	Compressor Design Pressure Ratio	Fan Bypass Ratio
PRIMARY CRUISE ENGINES	TURBOSHAFT ENGINES	1	2600	13	
		2	2600	16	
		3	2900	13	
		4	2900	16	
		5	2900	19	
		6	3200	13	
		7	3200	16	
		8	3200	19	
		9	3200	22	
	TURBOJET ENGINES	10	2600	13	
		11	2600	16	
		12	2900	13	
		13	2900	16	
		14	2900	19	
		15	3200	13	
		16	3200	16	
		17	3200	19	
		18	3200	22	
	TURBOFAN ENGINES	19,20,21	2600	16	2,4,6
		22,23,24	2600	20	2,4,6
		25,26,27	2900	16	2,4,6
		28,29,30	2900	20	2,4,6
		31,32,33	2900	24	2,4,6
		34,35,36	3200	16	2,4,6
		37,38,39	3200	20	2,4,6
		40,41,42	3200	24	2,4,6
		43,44,45	3200	28	2,4,6
LIFT ENGINES	INDEPENDENT LIFT ENGINES	46,47,48	2400	7	2,4,6
		49,50,51	2700	7	2,4,6
		52,53,54	3000	7	2,4,6
	GAS COUPLED LIFT FANS	55,56,57	2600	13	8,11,14
		58,59,60	2600	16	8,11,14
		61,62,63	2900	13	8,11,14
		64,65,66	2900	16	8,11,14
		67,68,69	2900	19	8,11,14
		70,71,72	3200	13	8,11,14
		73,74,75	3200	16	8,11,14
		76,77,78	3200	19	8,11,14
		79,80,81	3200	22	8,11,14

Table 4.2 VASCOMP II Engine Library

where V_T is input Loc (0181). By setting N2IND = 2, Loc (1204), turboshaft engine power at nonoptimum N_{II} will be calculated by the program by multiplying power at optimum N_{II} by a correction factor, K_{PN}, which is a function of $N_{II}/N_{II_{OPT}}$. The factor K_{PN} is normally calculated by the program and obeys a second order relationship:



Most, but not all, turboshaft engines will obey this relationship. For engine cycles whose performance is not properly represented by the above curve, the user may input a table of K_{PN} versus $N_{II}/N_{II_{OPT}}$ locations 1238-1257. The program uses input $N_{II}/N_{II_{MAX}}$ for each flight segment and $N_{II_{MAX}}/N_{II}$* for the engine cycle. The program uses this information to establish the value of $N_{II}/N_{II_{OPT}}$ for each point of flight.

By setting N2IND = 0 or 1, the program will assume that the power turbine is always operating at optimum speed and no correction will be applied. N2IND = 0 will simulate an engine cycle which is operating at optimum N_{II} and for which no upper limit has been placed on N_{II}. For many applications, this option will be perfectly adequate for preliminary sizing studies. The adequacy of this assumption can be determined by consideration of the following factors:

1. It may be desirable (e.g., as in the case of a tilt-rotor aircraft) to reduce the main rotor RPM in cruise flight.

2. For some applications this may, in turn, force the engine to operate at a very inefficient N_{II}. In general, the optimum N_{II} increases as output power increases relative to the maximum level.

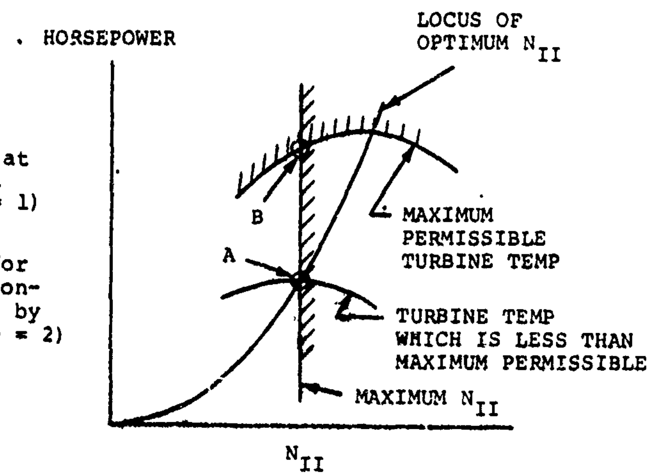
Consider the following case:

> Low disc loading aircraft will require a higher percentage of maximum power to fly at a specified airspeed than will high disc loading aircraft, assuming that engine power is dictated by a hover requirement. The low disc loading aircraft, therefore, will require a higher N_{II} for optimum engine performance than will the high disc loading aircraft. As a result, the low disc loading aircraft may be more severely compromised with respect to engine performance if the propeller rpm is reduced.

N2IND = 1 will simulate operation of an engine cycle at optimum N_{II}, but with the restriction of a maximum value for N_{II}. This type of operation is characteristic of airplanes employing fixed pitch propellers. Care should be taken in using this option because it may lead to a significant reduction in power available as shown by the sketch below:

A = Point of operation for aircraft flying at optimum N_{II}, limited by $N_{II\ MAX}$. (N2IND = 1)

B = Point of operation for aircraft flying at non-optimum N_{II}, limited by same $N_{II\ MAX}$. (N2IND = 2)



N2IND = 2 is similar to N2IND = 1 except the operational flying point is located at a nonoptimum N_{II}.

Limitations on engine cycle operation may be input to the program on any combination of the following:

- fuel flow WDTIND Loc (1201) =
  - 0. = no fuel flow cutoff
  - 1. = fuel flow cutoff specified by W_{MAX}/W^* Loc (1220).
- gas generator speed, N1IND Loc (1202) =
  - 0. = no gas generator speed cutoff
  - 1. = gas generator speed cutoff specified by $\frac{N_{I\ MAX}}{N_{I*}}$ Loc (1221)

- gas generator referred RPM, N1θIND Loc (1203) =
  0. = no referred RPM cutoff
  1. = referred RPM cutoff specified by

$$\frac{N_I}{\sqrt{\theta_1}\, N_I{}^*} \qquad \text{Loc (1222)}$$

- output shaft speed N2IND Loc (1204) =
  0. = no output shaft speed cutoff
  1. = output shaft speed cutoff specified by optimum $\frac{N_{II_{MAX}}}{N_{II}{}^*}$ Loc (1223).
  2. = output shaft speed cutoff specified by nonoptimum $\frac{N_{II_{MAX}}}{N_{II}{}^*}$ Loc (1223).

- torque, QIND Loc (1205) =
  0. = no torque limit
  1. = torque limit imposed on main and tail rotor transmission specified by Q_{MAX}/Q^* Loc (1224).
  2. = torque limit imposed on auxiliary propulsion transmission specified by Q_{MAX}/Q^* Loc (1224).

Engine ratings (power settings) are dictated by turbine temperature. Five discrete values of that parameter are input for the primary engine cycles, one for each of the following power settings: maximum, military, normal, flight idle, and ground idle.

The program will print out, during the mission, the value of turbine temperature and a code that designates which condition is governing the engine performance at that point: power or thrust required, turbine temperature, torque limit, N_I limit, referred N_I limit, N_{II} limit, or fuel flow limit.

Manufacturer's data on some engines show significant variations in both referred power ($shp/\delta\sqrt{\theta}$) and lapse rate with respect to changes in altitude. These variations are due to Reynolds' number effects. It has been found that these effects can be accounted for by means of a multiplicative factor on power available which is a function of the Reynolds number based on compressor inlet conditions, compressor blade geometry, and tip speed. Figure 4-4 shows a typical curve for a real engine. The correction factor K_{PR} is input to the program as a function of the Reynolds' parameter

$$\frac{N_I}{N_I^*}\,\frac{D}{\nu_1}\,.$$

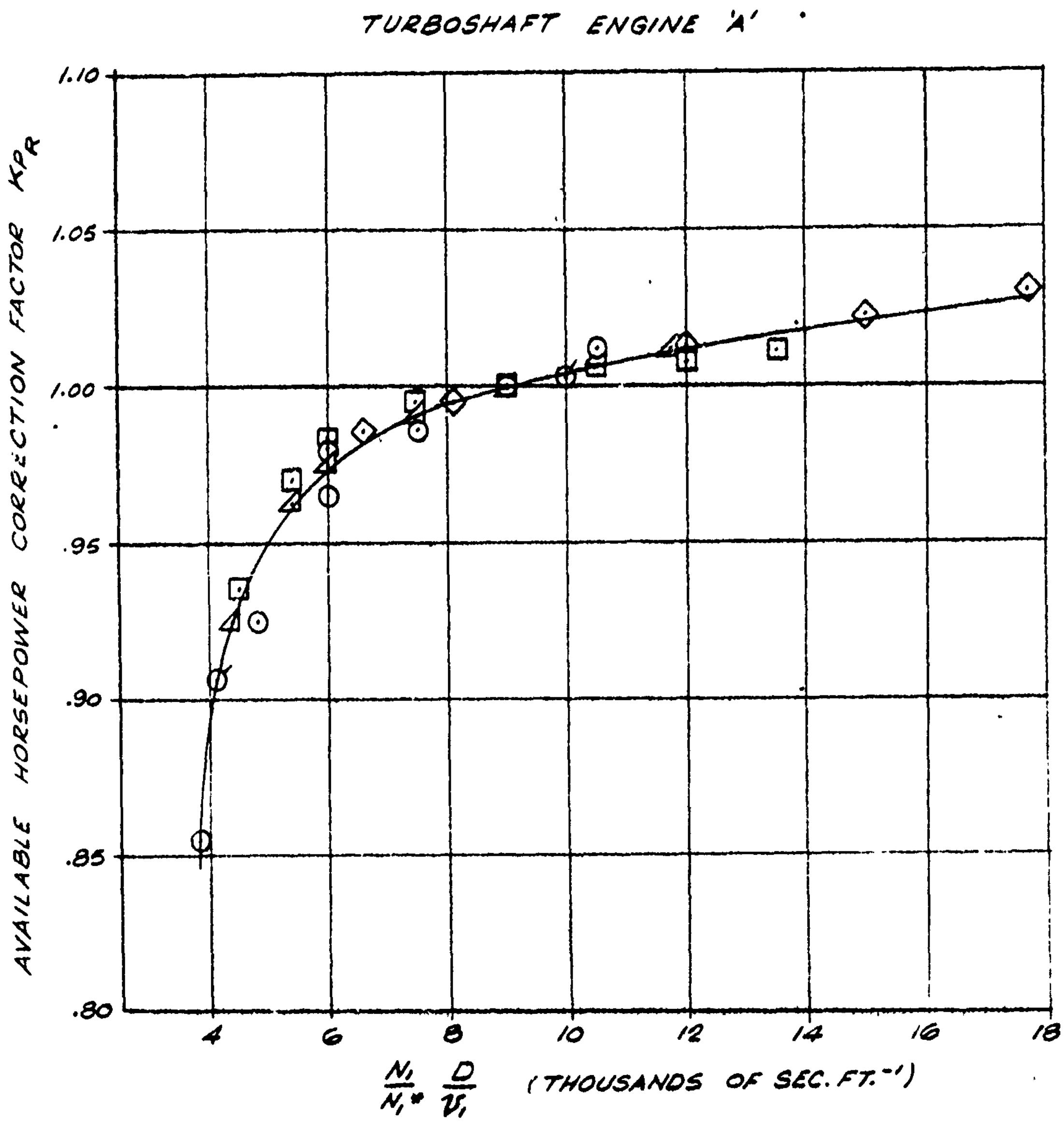


Figure 4-4. Typical Reynolds' Number Correction Factor for a Turboshaft Engine Cycle.

The tabular input of power, fuel flow, N_I, and N_{II} for engines which require Reynolds number corrections should be input to the program at a nominal fixed value of the Reynolds number parameter. The K_{PR} correction factor will then give the power at other values of the Reynolds number parameter. In the example shown in Figure 4-4, the nominal value of the parameter was chosen as 9000 seconds/foot.

The referred N_I limit is a constraint on the value of $N_I/\sqrt{\theta_1}$ where θ_1 is the temperature ratio at the compressor face. This limit simulates a restriction on compressor speed. The user inputs a maximum value of $N_I/N_I^*\sqrt{\theta_1}$.

The engine dry weight and dimensions are calculated by means of the input parameters k_3, k_{3_I}, k_4, k_{4_I}, ξ_4 and ξ_{4_I}:

Primary engines

$$\text{weight (lb)} = k_3 \frac{F_N^*}{N_P} + k_4 \text{ or } k_3 \frac{SHP^*}{N_P} + k_4$$

$$\text{diameter (ft)} = \xi_4 \left[\frac{F_N^*}{N_P}\right]^{1/2} \text{ or } \xi_4 \left[\frac{SHP^*}{N_P}\right]^{1/2}$$

N_P = number of primary engines

Lift engines

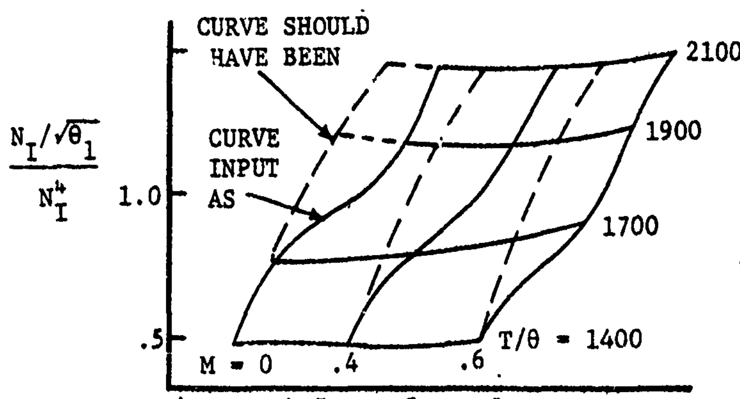
$$\text{weight (lb)} = k_1 \cdot \frac{F_{N_L}^*}{N_L} + k_2$$

$$\text{diameter (ft)} = \xi_1 \left[\frac{F_{N_L}^*}{N_L}\right]^{1/2}$$

$$\text{length (ft)} = \xi_2 + \xi_3 \left[\frac{F_{N_L}^*}{N_L}\right]^{1/2}$$

N_L = number of lift engines

It has been found that the VASCOMP program can react in an extremely sensitive manner to "bumps" in the engine cycle data. Extreme care should be taken to ensure that the engine data which is input is smooth and continuous. In a particular example which was studied extremely erratic climb profiles resulted during maximum rate of climb mission segments. The speed for maximum rate of climb for example, jumped from 200 KTAS at 12,000 feet to 330 KTAS at 13,000 feet, during a climb from sea level to 25,000 feet in 1,000 foot increments. These anomalies were traced to inflections in the engine cycle curves of referred N_I versus turbine temperature and Mach number. (See Figure 4-5).



Note that the program read the input data for N_I as having an inflection. This was due to input error and the curve, in reality, should have been smooth.

Figure 4.5 Referred N_I as a Function of Mach No. and Temperature

The interpolation routine used with the engine data is a second-order curve-fitting method using the point closest to the desired value and the points immediately above and below to generate a second-order curve to obtain the intermediate values. As a result, when the independent variable is in the region of an inflection, a discontinuity occurs in the dependent variable. For example, Figure 4-6 shows the variation of turbine temperature, T, with Mach number, M, as calculated for the referred N_I limit at 13,000 feet.

Points 1 through 4 have been calculated using the discrete values of M (M= 0, .4, .6, .8) input to the test case. Curve A is the interpolation curve usings points 1, 2, and 3, while curve B uses 2, 3 and 4. When M becomes greater than about .5, a sudden jump in T results, as curve B is then considered more valid than curve A; M is then closer to 0.6 than to 0.4. The solid line indicates the intended variation of T with M.

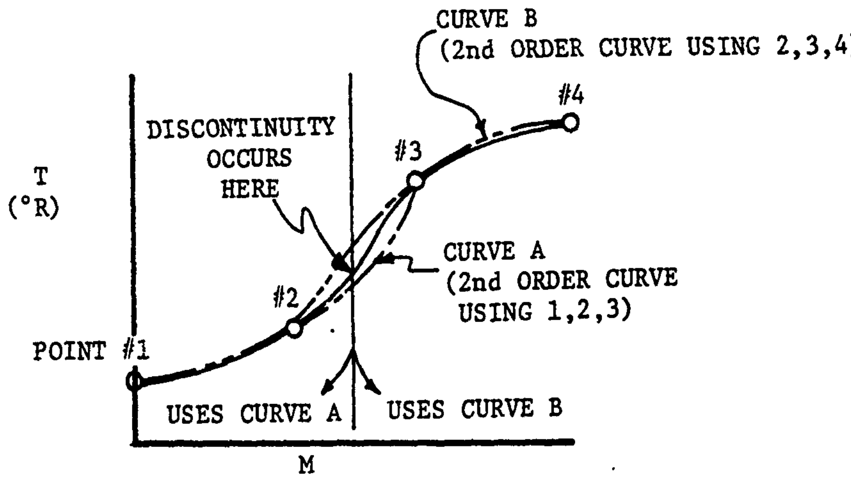


Figure 4-6. Variation of Turbine Temperature vs. Mach Number

This sudden change in T causes a corresponding jump in available horsepower and rate of climb. This causes a local peak in the variation of R/C with speed, and can cause an erroneous maximum rate of climb speed. This is because the program is searching for maximum rate of climb by working from high speed (V_{MO}) to lower speeds. In Figure 4-7, we see that at altitudes greater than 13,000 feet

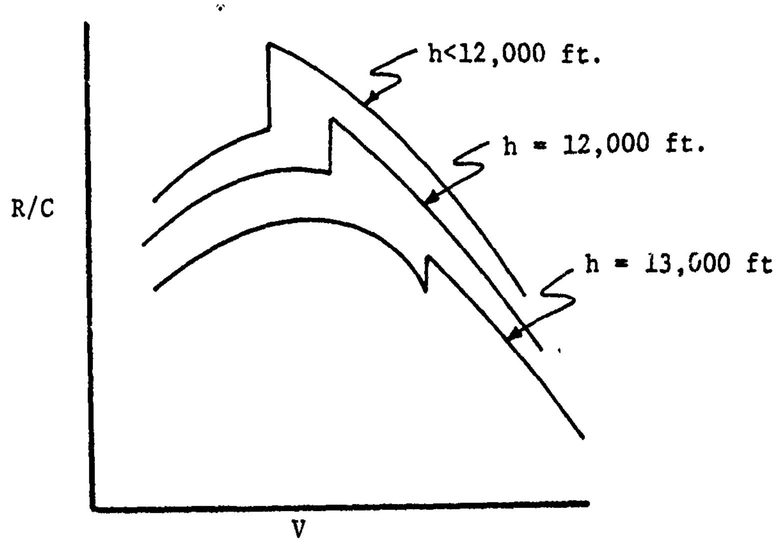


Figure 4-7. Variation of Rate of Climb vs. Velocity

the climb routine would pick up this local peak and we see a dramatic change in speed for a small change in altitude because of engine cycle curves with inflections. Such data may well be incorrect, and may cause inexplicable discontinuities in the output.

Figures 4-8 through 4-14 are flow charts of the engine cycle subroutines. The purpose of these subroutines is described in Table 3-1.

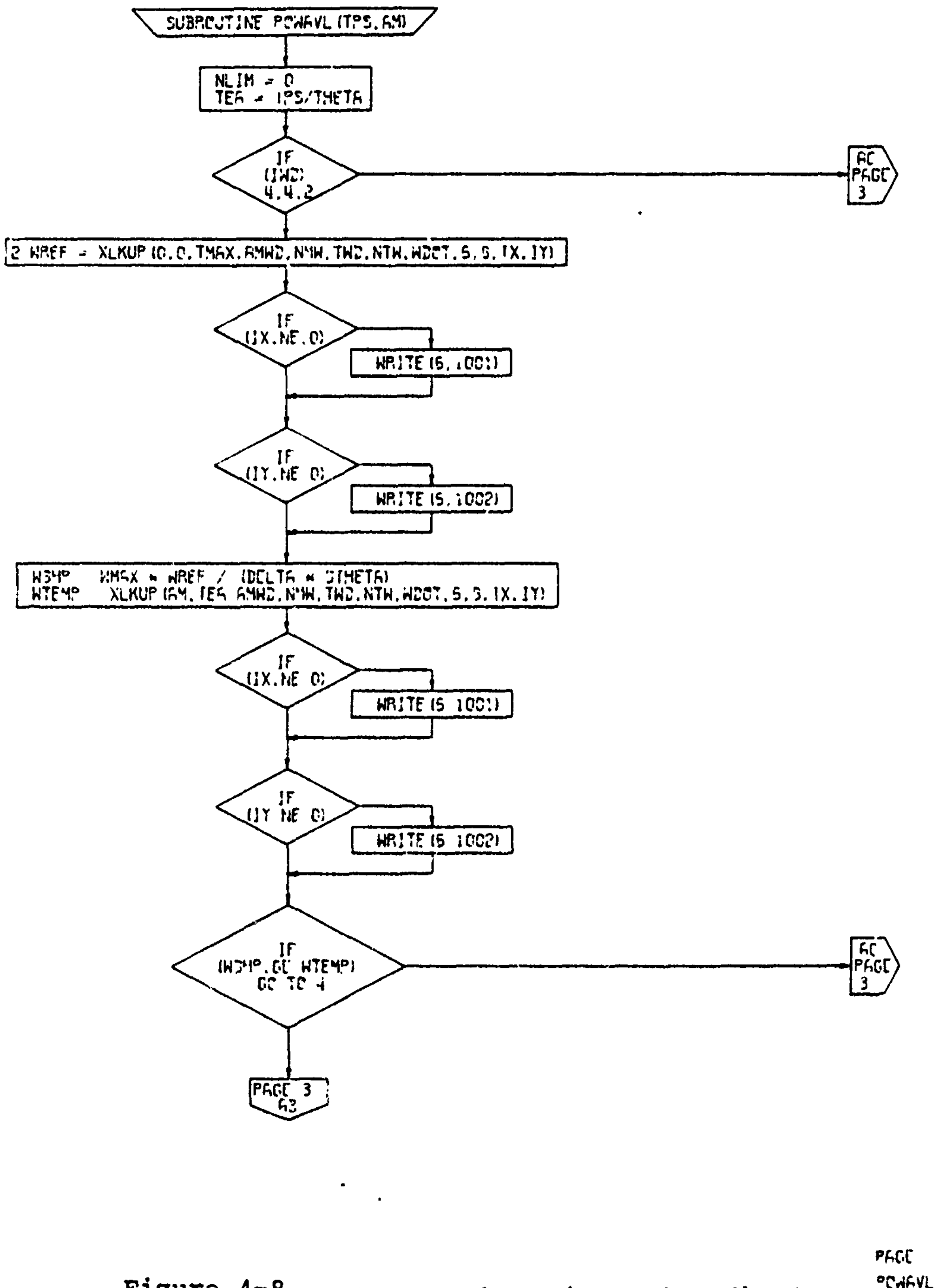


Figure 4-8. POWAVL Subroutine, Flow Chart (Part 1 of 7)

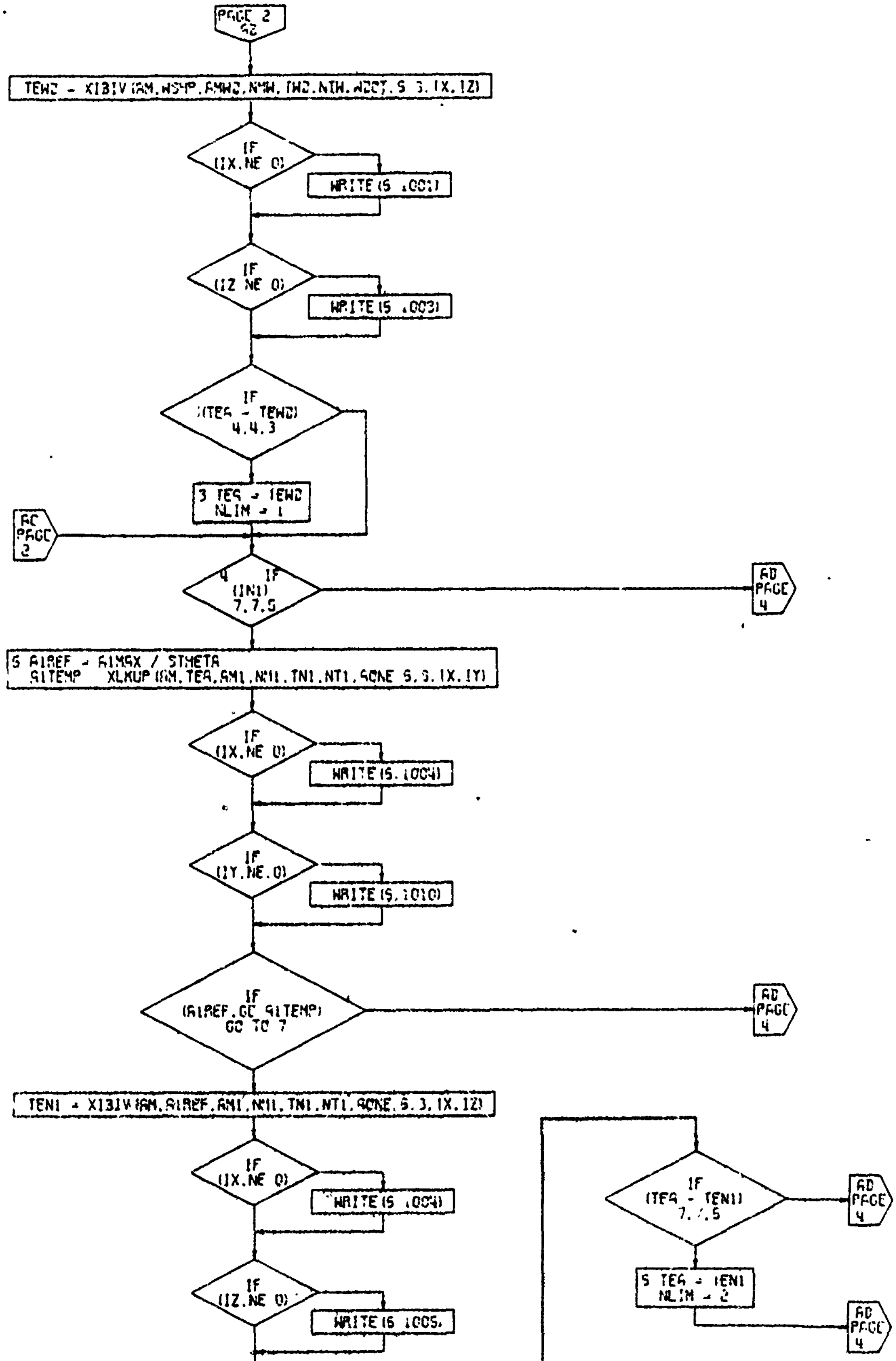


Figure 4-8. POWAVL Subroutine, Flow Chart
(Part 2 of 7)

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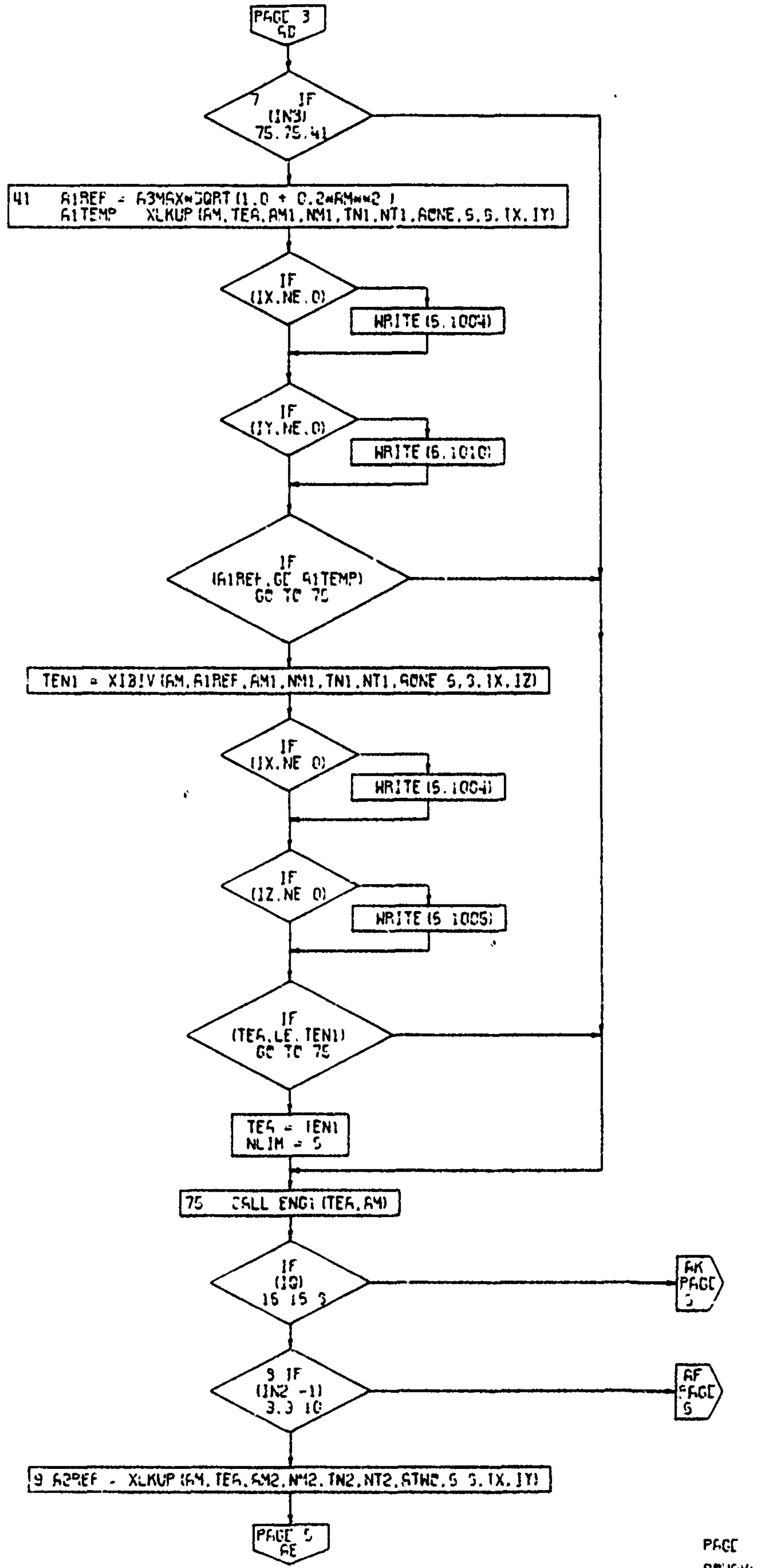

Figure 4-8. POWAVL Subroutine, Flow Chart
(Part 3 of 7)

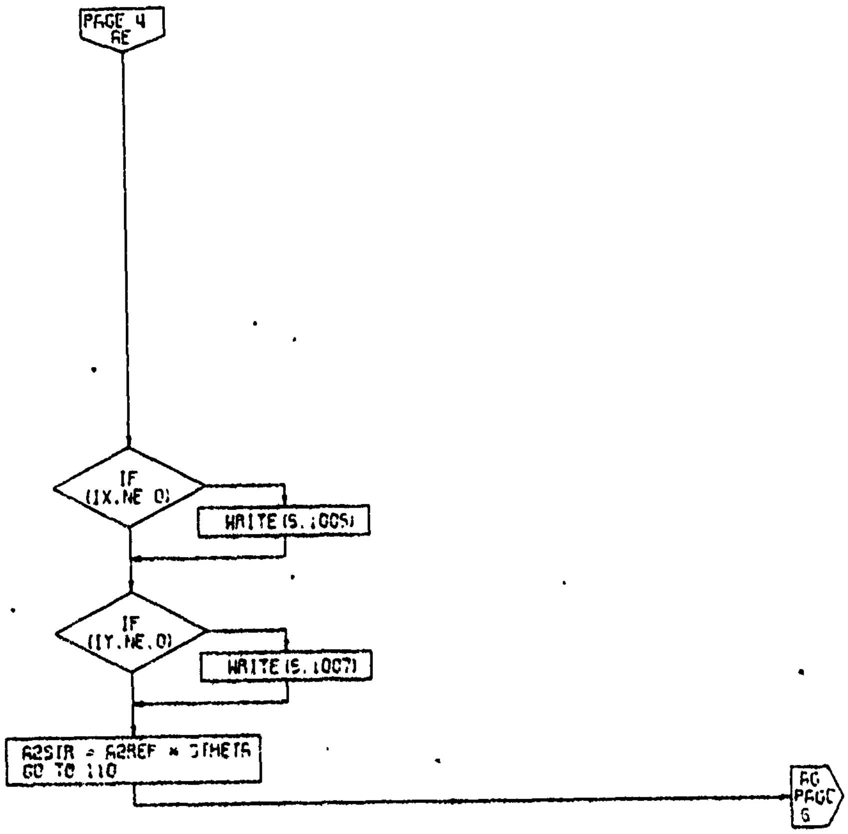

Figure 4-8. POWAVL Subroutine, Flow Chart
(Part 4 of 7)

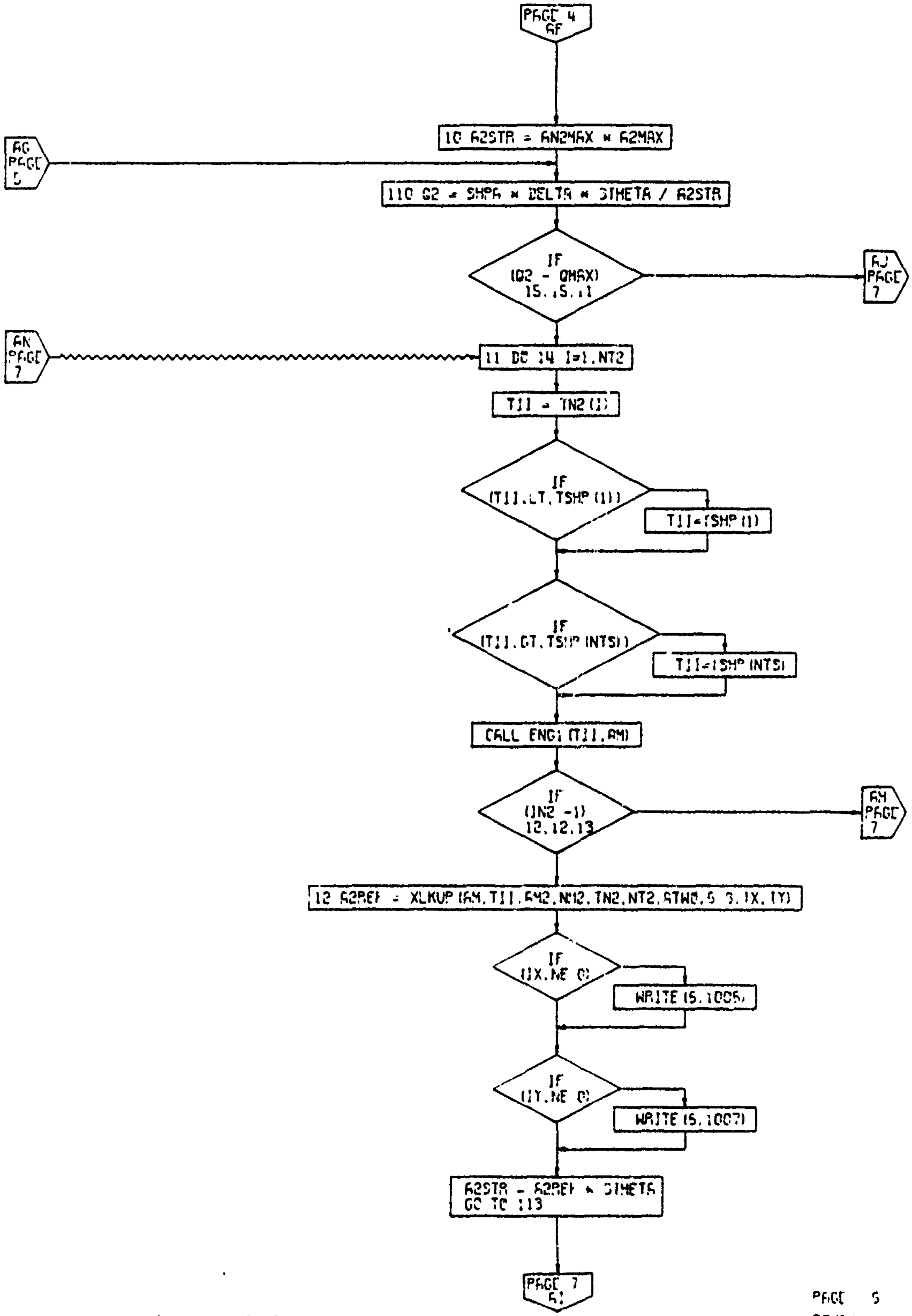

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Figure 4-8. POWAVL Subroutine, Flow Chart
(Part 5 of 7)

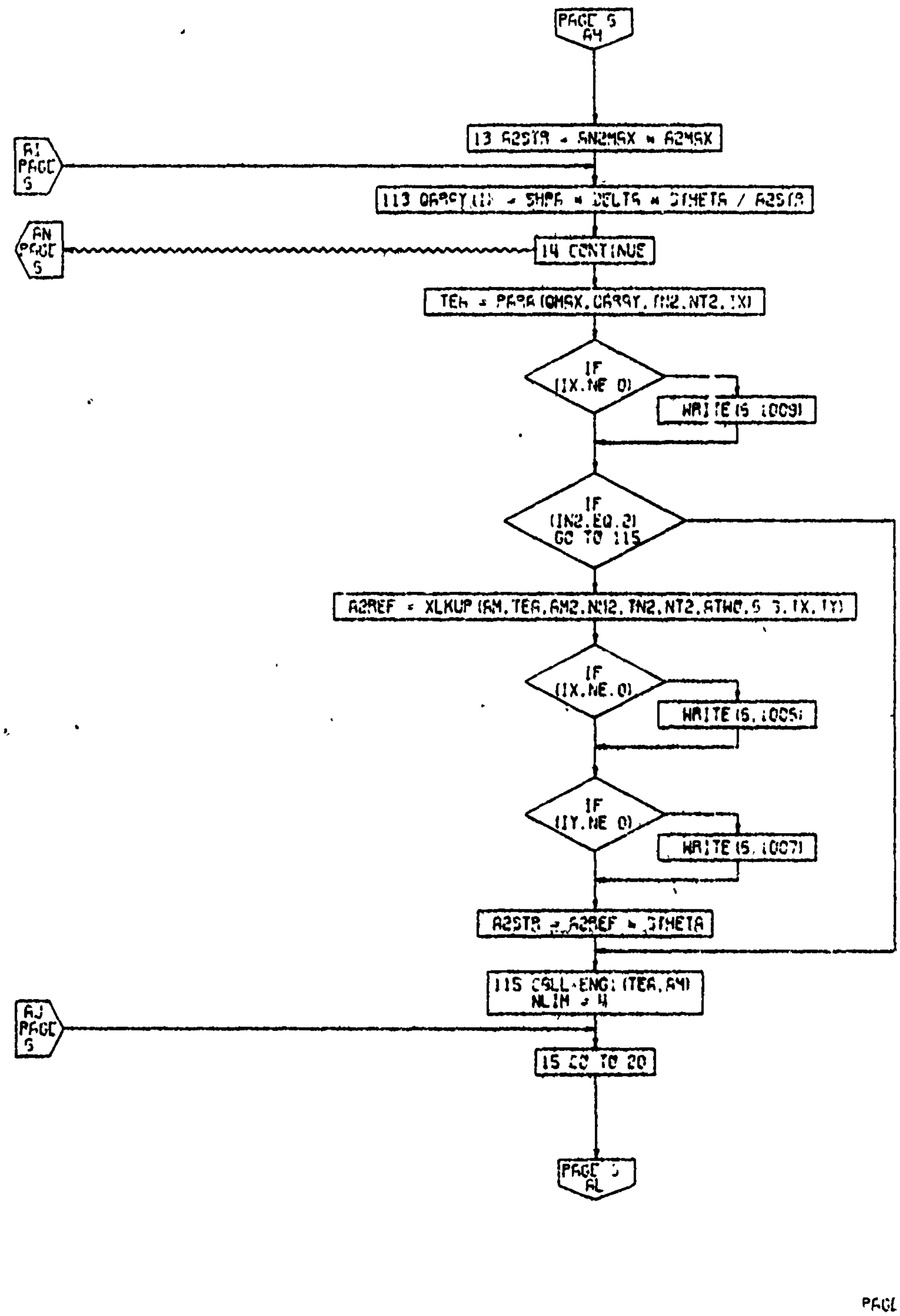

Figure 4-8. POWAVL Subroutine, Flow Chart
(Part 6 of 7)

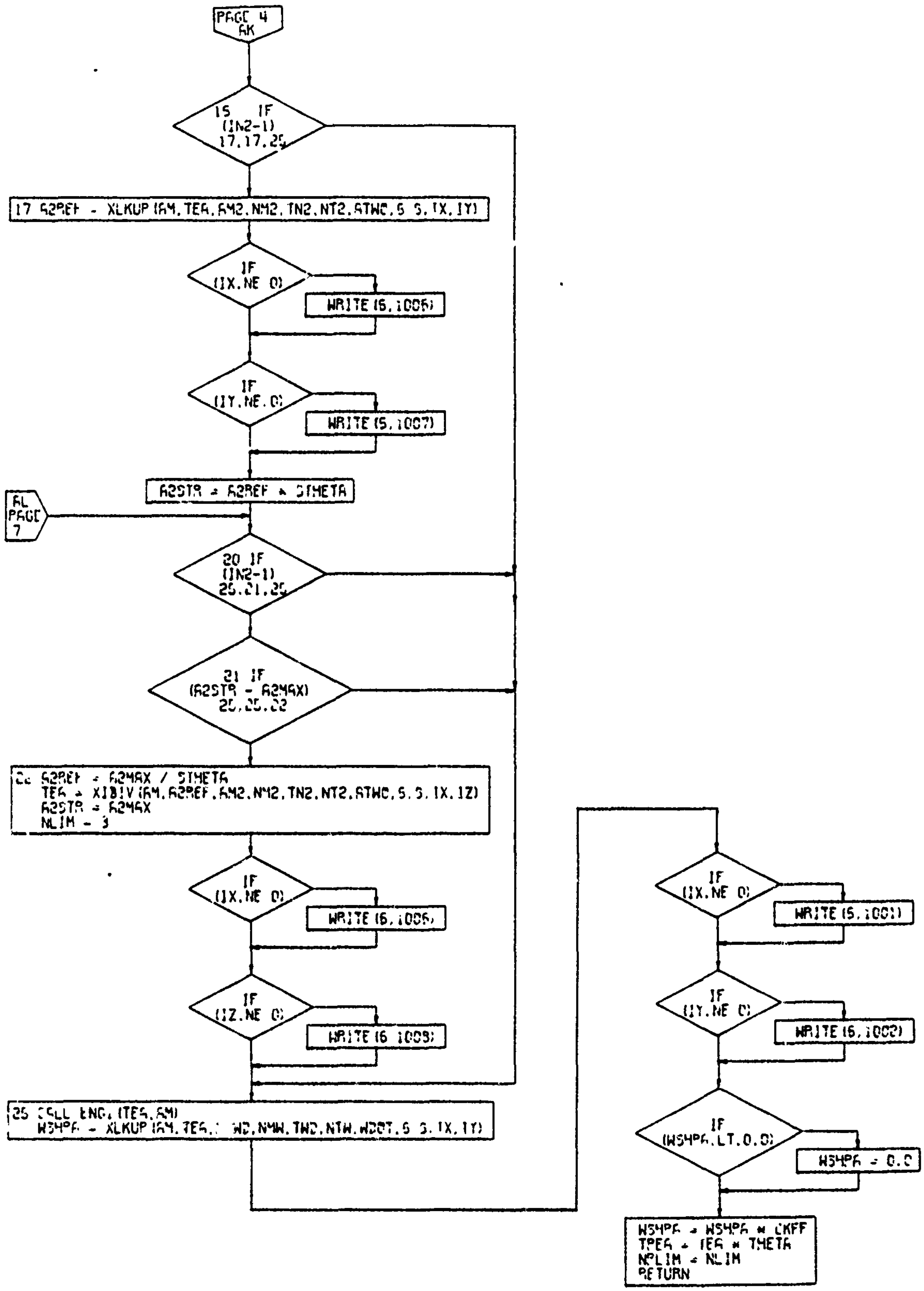

Figure 4-8. POWAVL Subroutine, Flow Chart (Part 7 of 7)

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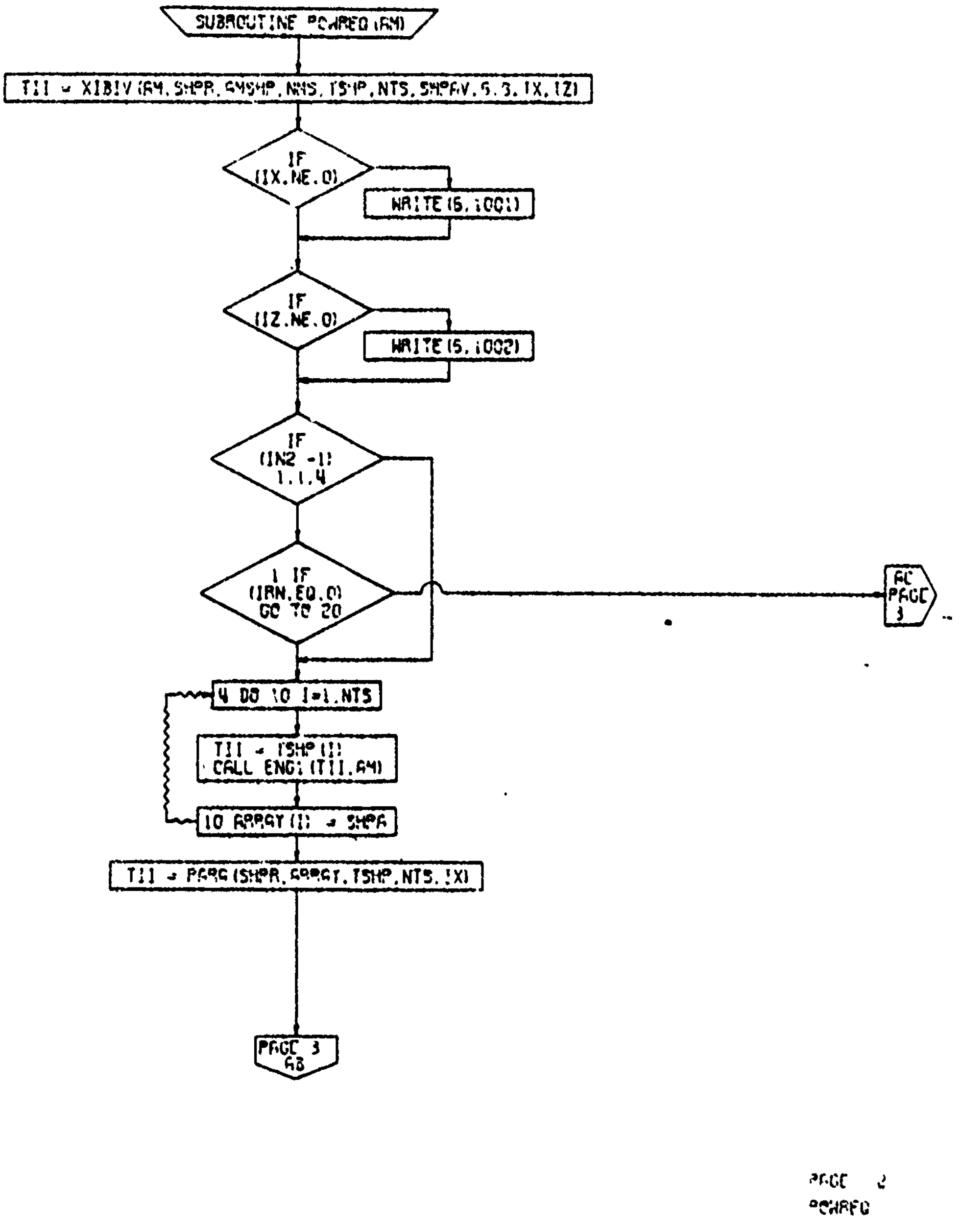
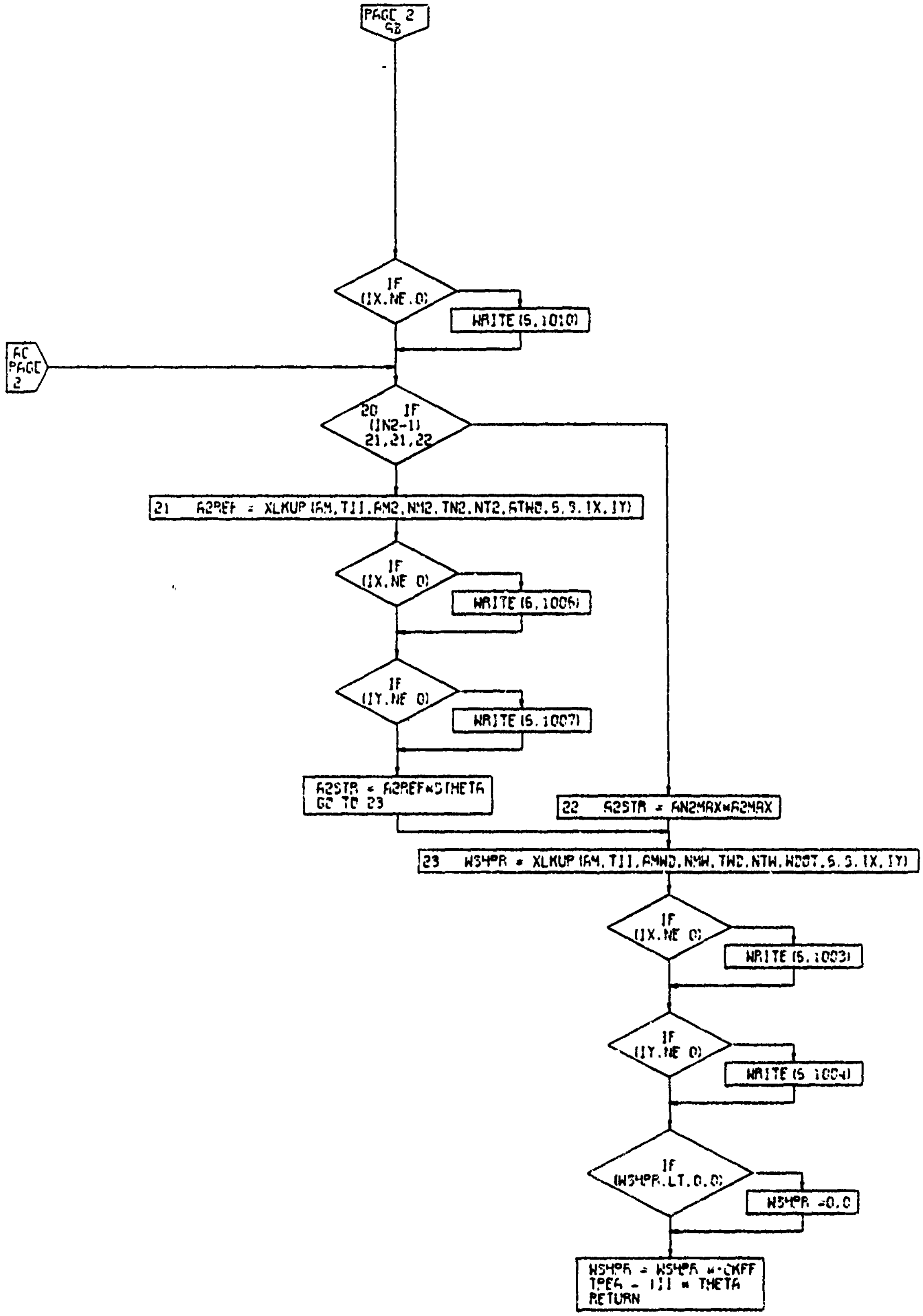


Figure 4-9. POWREQ Subroutine, Flow Chart (Part 1 of 2)



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POWREQ

Figure 4-9. POWREQ Subroutine, Flow Chart (Part 2 of 2)

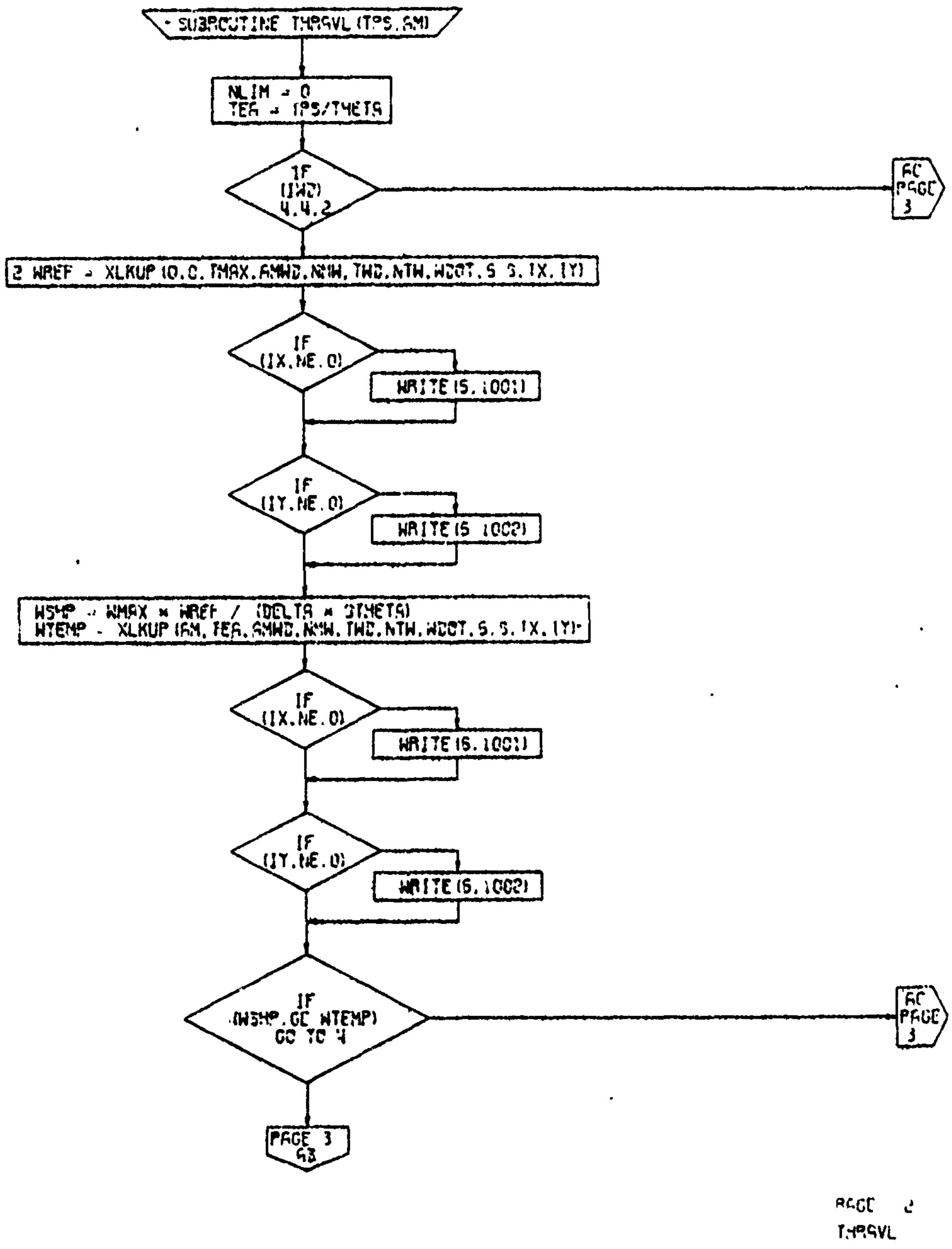

Figure 4-10. THRAVL Subroutine, Flow Chart
(Part 1 of 4)

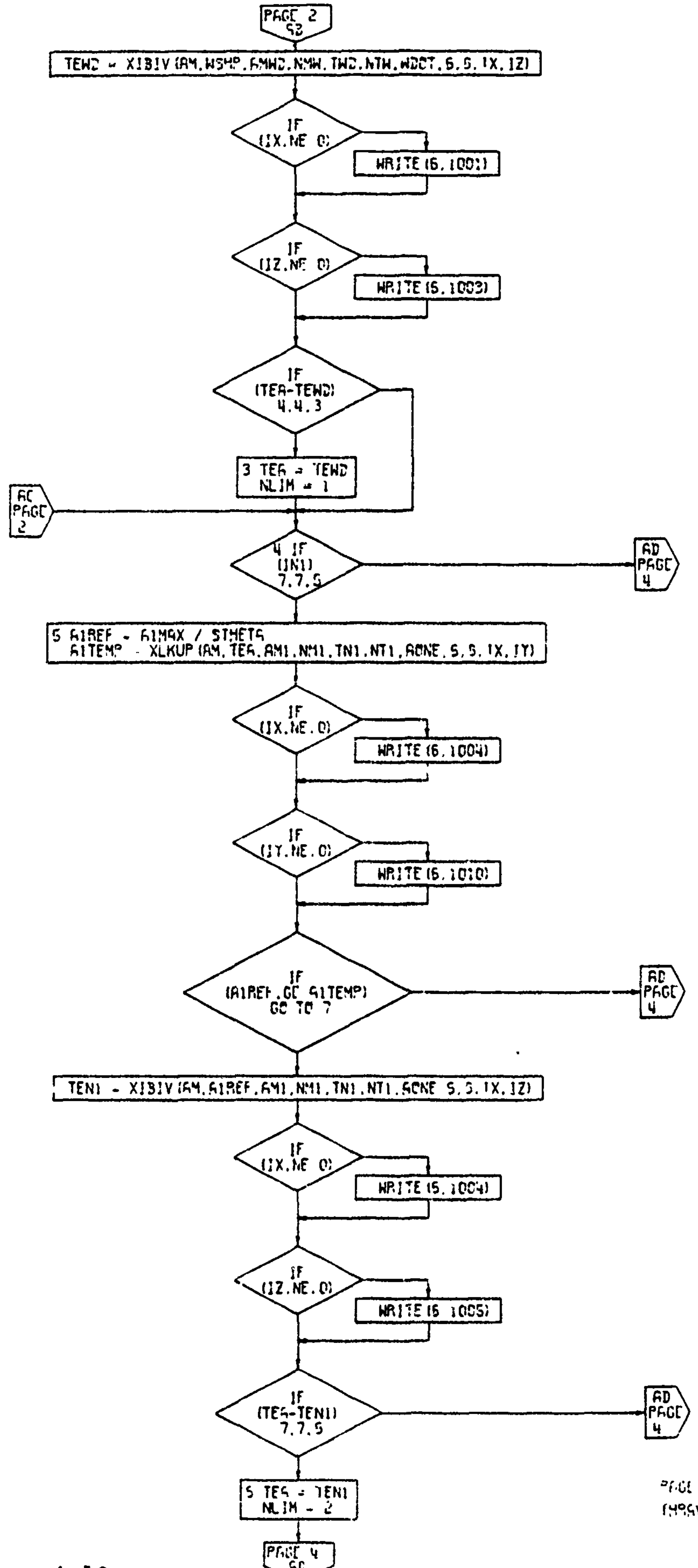

Figure 4-10. THRAVL Subroutine, Flow Chart (Part 2 of 4)

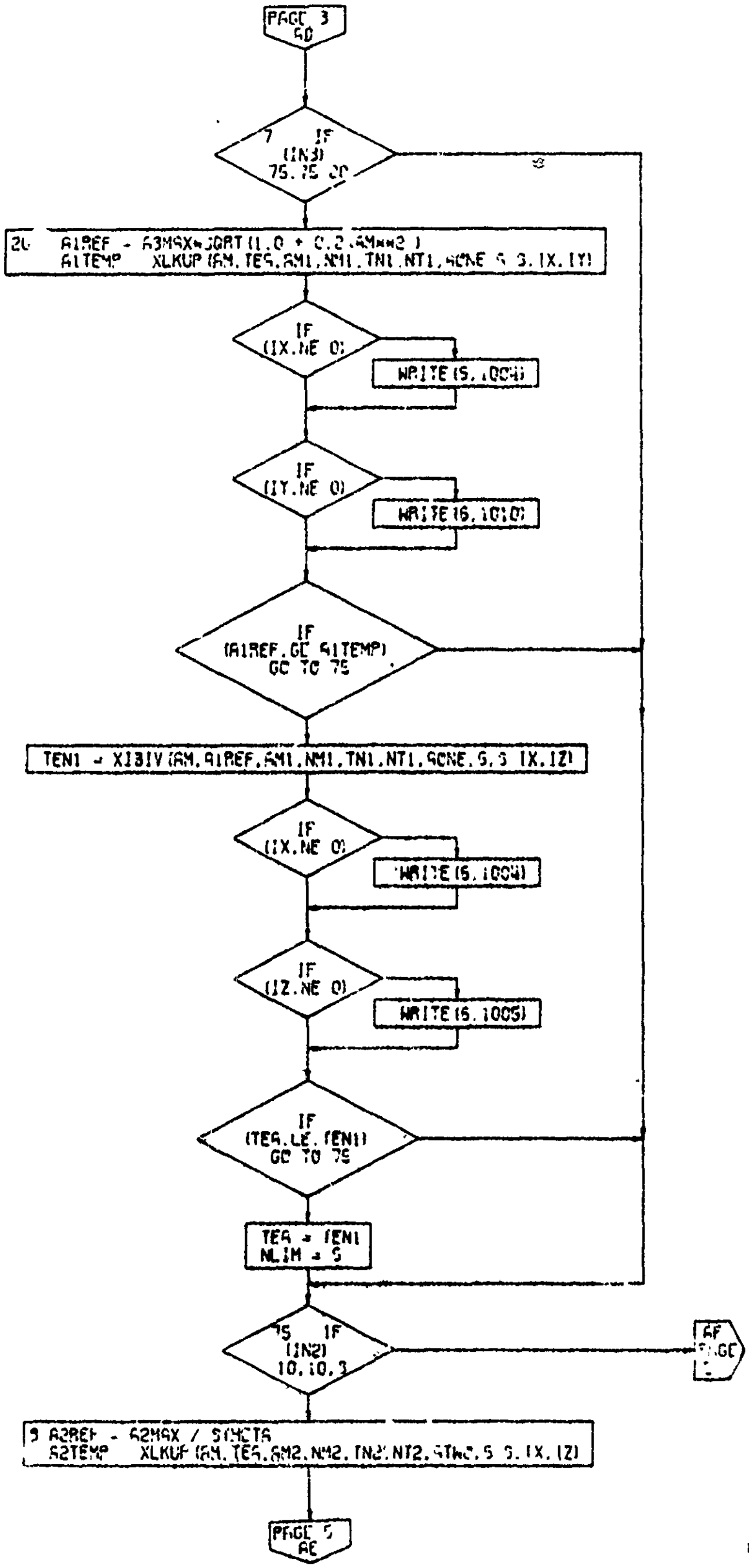

Figure 4-10. THRAVL Subroutine, Flow Chart
(Part 3 of 4)

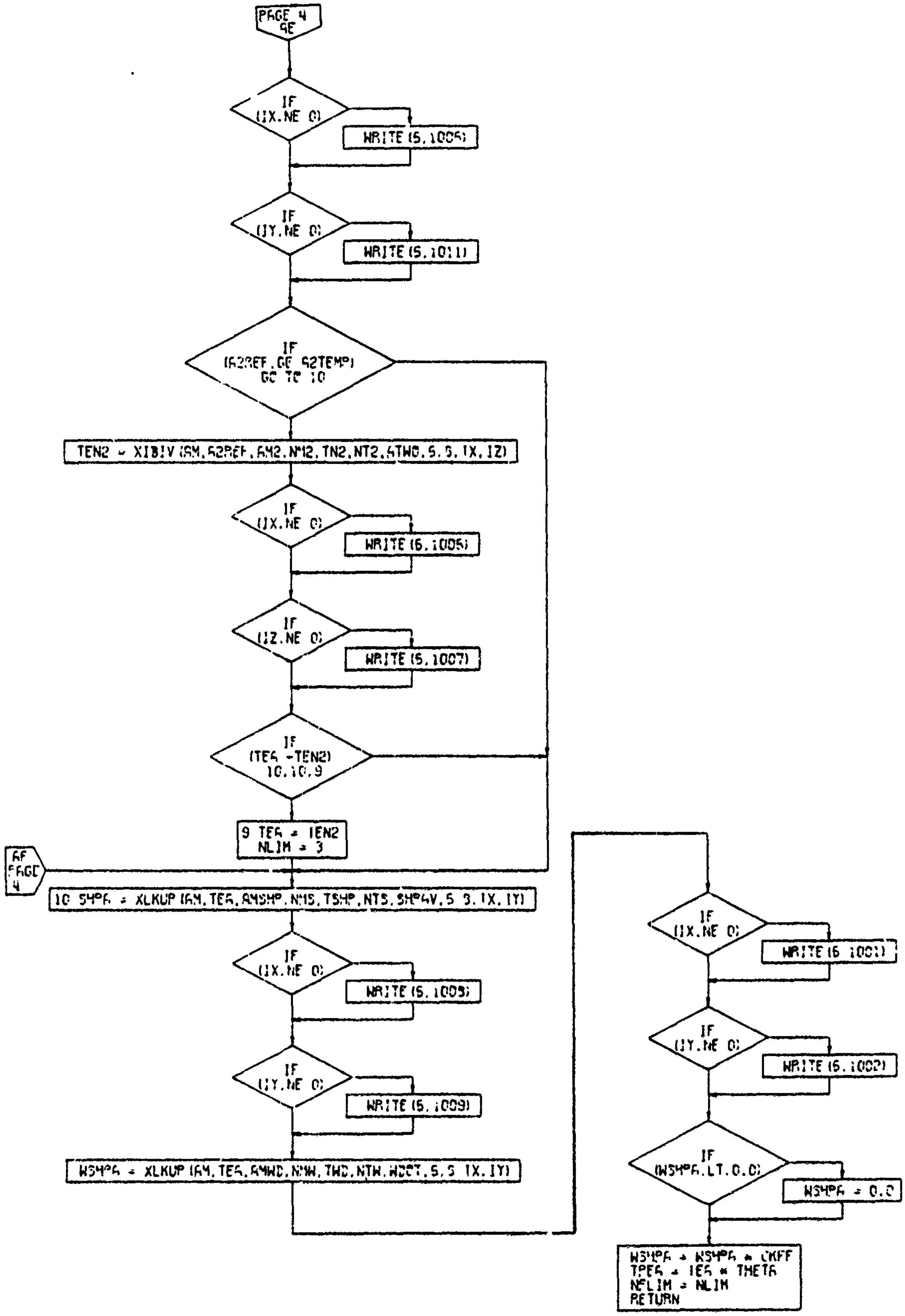

Figure 4-10. THRAVL Subroutine, Flow Chart
(Part 4 of 4)

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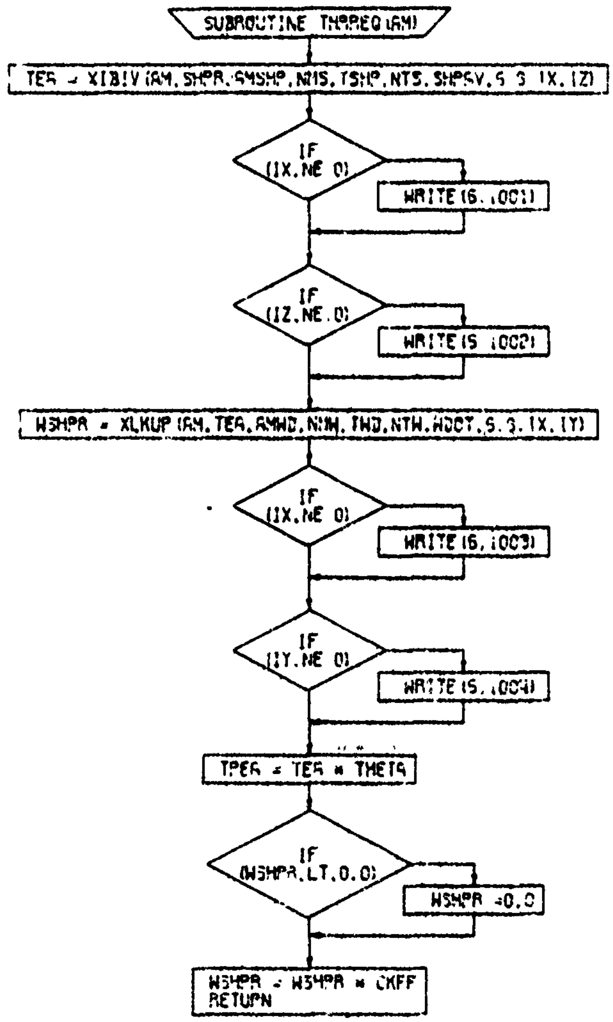


Figure 4-11. THRREQ Subroutine, Flow Chart

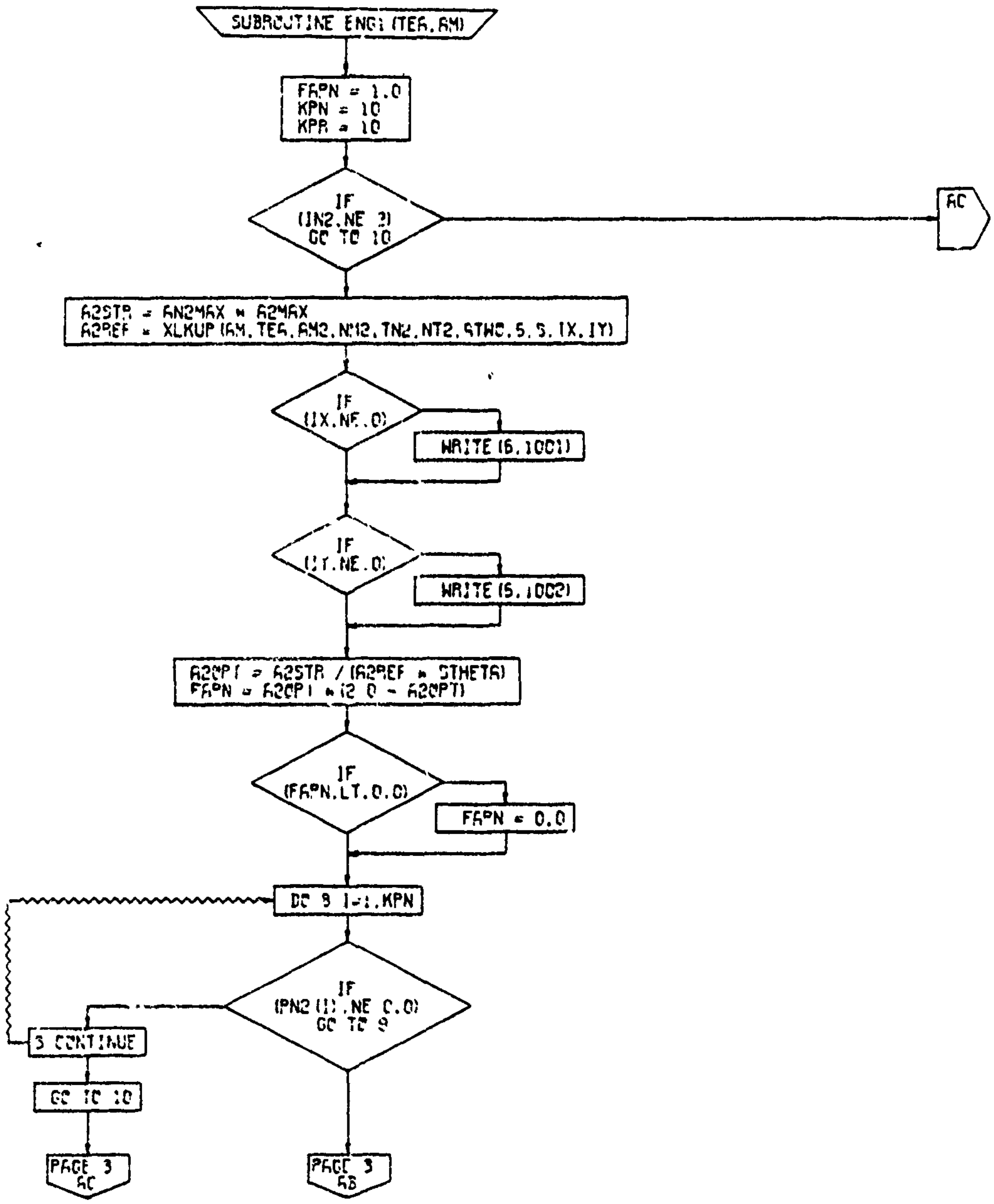


Figure 4-12. ENG1 Subroutine, Flow Chart
(Part 1 of 2)

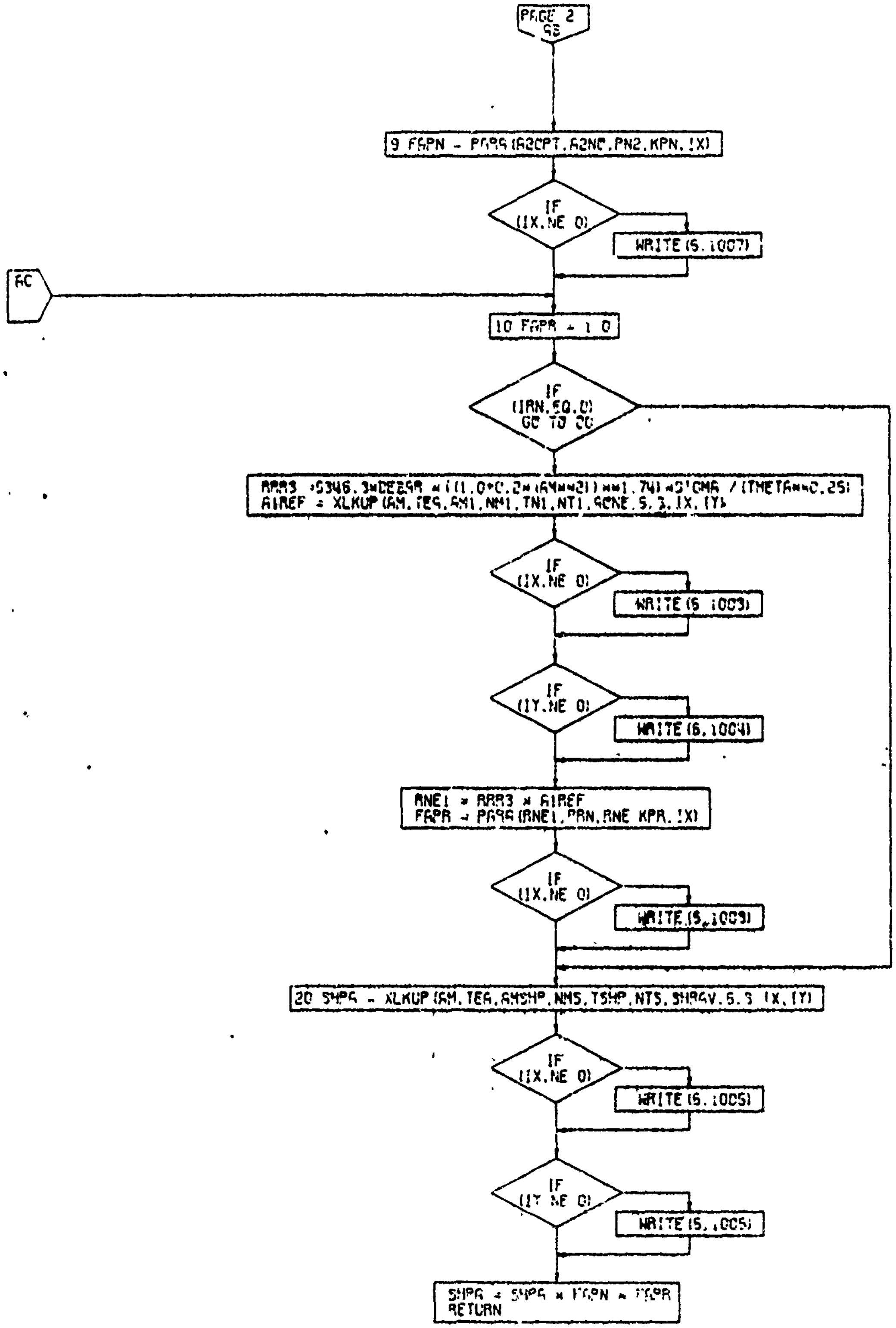


Figure 4-12. ENG1 Subroutine, Flow Chart
(Part 2 of 2)

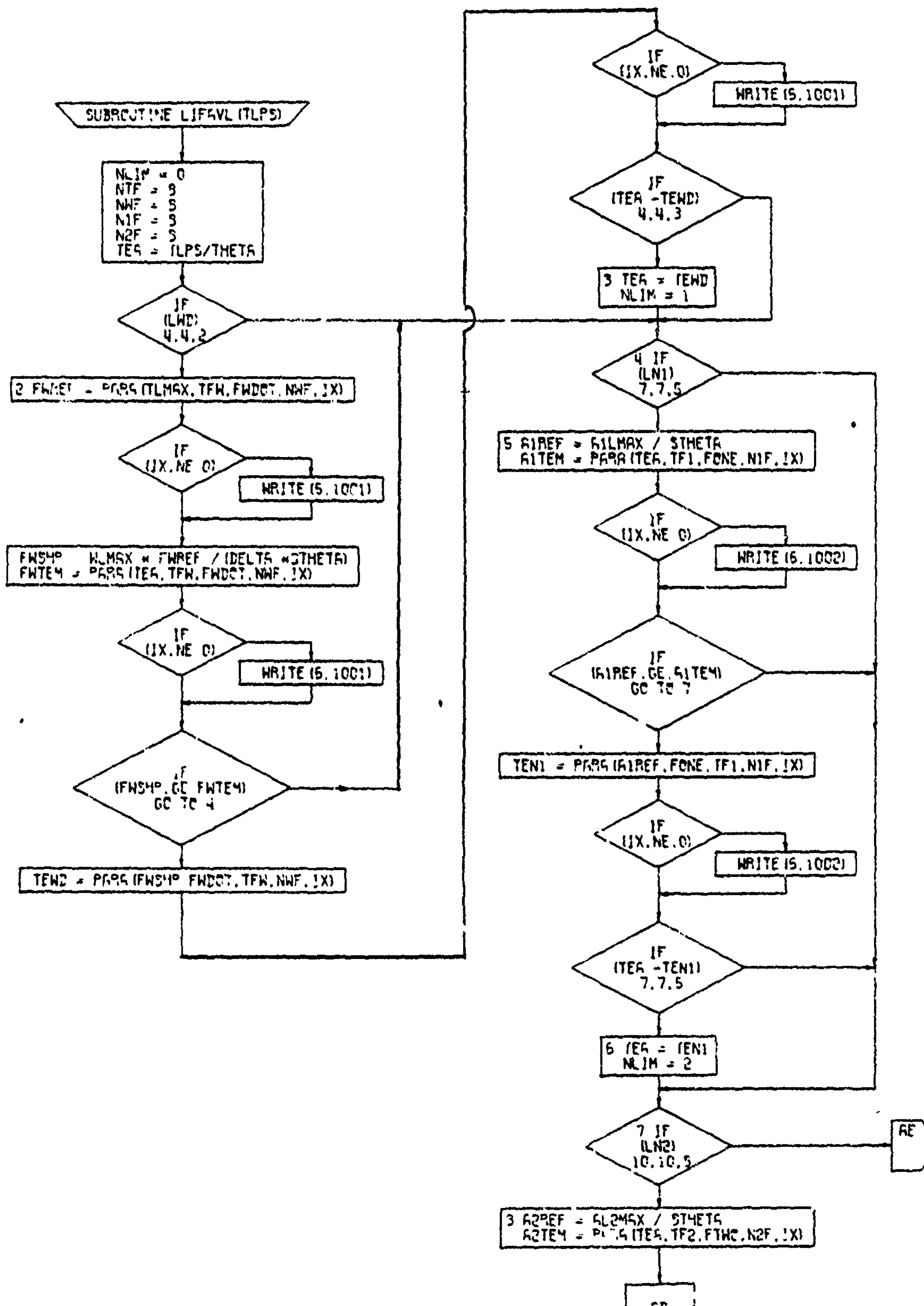


Figure 4-13. Lift Available Calculations Subroutine, Flow Chart (Part 1 of 2)

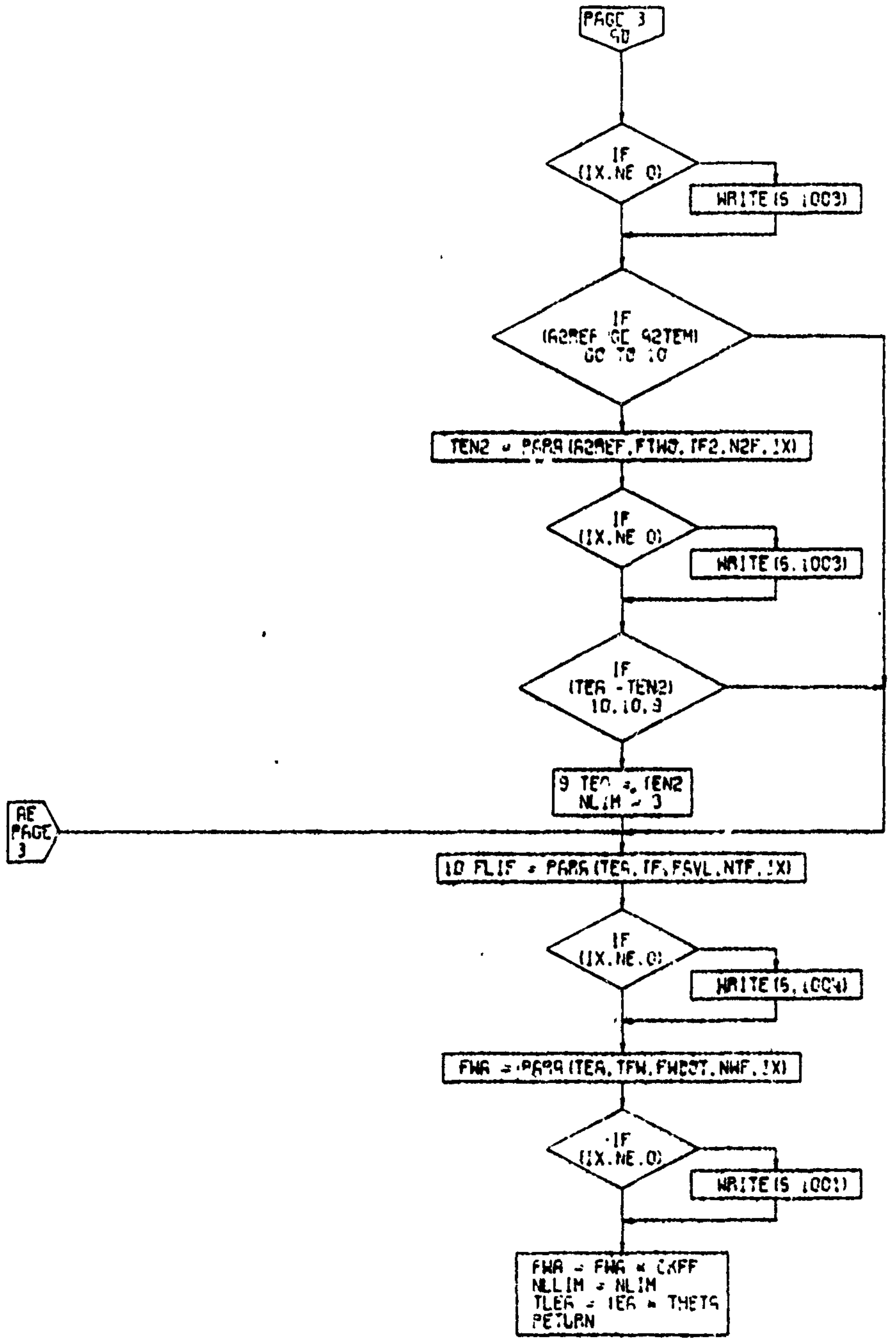


Figure 4-13. Lift Available Calculations Subroutine, Flow Chart (Part 2 of 2)

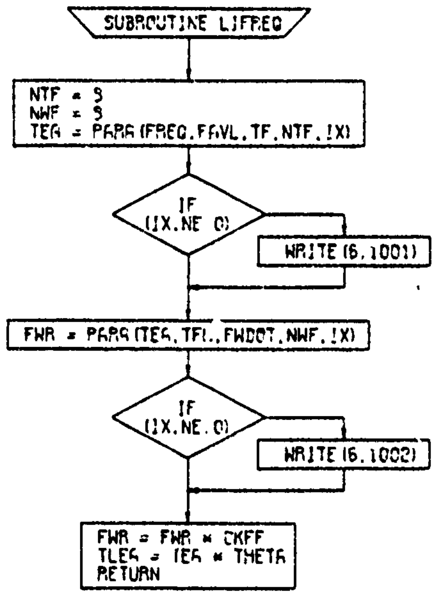


Figure 4-14. Lift Required Subroutine, Flow Chart

4.5 PROPELLER PERFORMANCE CALCULATIONS

Four different options are available for representing the performance of propellers when using turboshaft engines (ENGIND=0). The option to be used is specified to the program by means of a prop efficiency indicator - "η_pIND".

η_pIND=0 The user inputs a set of point values for the prop efficiency for the performance segments of takeoff, climb, and descent and a table of efficiency as a function of flight Mach number for cruise and loiter. The following input is required:

- η_{p2} - The static propeller efficiency (Figure of Merit) to be used in calculation of Takeoff, Hover and Landing (SGTIND=2) is input as a single point value. It should be noted that η_{p2} is also a required input for jet engines (ENGIND=1) or for convertible engines (ENGIND=2). In the former case η_{p2} may be used to represent the turning efficiency of jet engines being used with turning vanes. In the latter case it represents the Figure of Merit of the props or rotors being used with the convertible engines.

- η_{p3} - A single point value is input for the prop efficiency during climb (SGTIND=3).

- η_{p4} - A table is input of prop efficiency during cruise (SGTIND=4) and Loiter (SGTIND=6) as a function of flight Mach number.

- η_{p5} - A single point value is input representing the prop efficiency during Descent (SGTIND=5).

The primary advantage of this option of propeller performance representation is that it permits rapid evaluation of the sensitivity of aircraft performance and size to changes in propeller performance. For example, a series of runs with different values of η_{p2} and η_{p4} will quickly show the tradeoff between Figure of Merit and cruise efficiency for a family of propellers. It may also prove desirable to use this option in early conceptual studies when a specific prop has not been picked and it is desired to use "reasonable" values of efficiency.

TABLE 4-3
PROPELLER CHARACTERISTIC SUMMARY

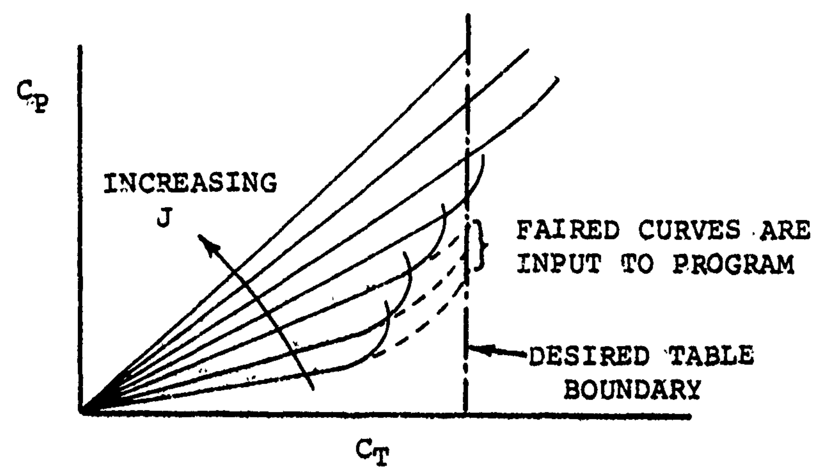
ALL PROPELLERS ARE 3-BLADED, CONSTANT SPEED

MANUFACTURER	DESIGNATION	INTEGRATED DESIGN C_L	ACTIVITY FACTOR PER BLADE	APPLICATION
HARTZELL PROPELLERS, INC.	T10282H	0.555	114 (118)*	TWIN OTTER SKYVAN
HARTZELL PROPELLERS, INC.	10173-8	0.62 (0.7)*	104 (107)*	KINGAIR BEECH 99
HAMILTON STANDARD DIVISION, UAC	33LF 1033A-0	0.424	127	HAWK COMMANDER
HAMILTON STANDARD DIVISION, UAC	33LF 1027A-0	0.5	110	
HAMILTON STANDARD DIVISION, UAC	33LF 1013A-0	0.483	97	

NOTE: VALUES IN PARENTHESES ARE QUOTED BY HARTZELL PROPELLERS. THE VALUES NOT IN PARENTHESES ARE CONSISTENT WITH THE BLADE GEOMETRIC DATA SUPPLIED BY HARTZELL.

Table 4.3 Propeller Characteristic Summary

$\underline{\eta_p IND=1}$ - This option permits the user to input a table representing the performance of the propeller throughout the flight envelope with the exception of DESCENT (SGTIND=5) for which a value of $\underline{\eta_{p5}}$ is input as before. For all other performance segments the table, input in the format of Cp (prop power coefficient) as a function of C_T (prop thrust coefficient) and J (advance ratio), is used. The table which is prepared must include all compressibility losses for the known tip speed at which the propeller is intended to operate. The user is cautioned that the tabular values must be monotonic. That is, the table cannot include the maximum in C_T which reflects blade stall at high values of Cp. This must be faired out as shown in the sketch below:



The advantage of this option is that it permits the user to input the performance of a real propeller as determined from test data.

A previous NASA contract for the modification of VASCOMP II required the preparation of propeller performance data for five general aviation propellers. These data are in the form of card decks and are for use with the η_pIND = 1.0 option for propeller calculations.

The characteristics and applications of each of these propellers is summarized in Table 4-3. The propeller table number (INPUT LOCATION 0256) to be specified is indicated in the table. These propeller decks are available for use with VASCOMP II. In addition to specifying the "propeller table number" in his input, the user should also indicate on his job required card that the particular propeller deck is required.

Propeller Designation	Table Number
Hartzell T10282H	10282.3
Hartzell 10173-8	101738.3
Hamilton Standard 33LF 1033A-O	1033.3
Hamilton Standard 33LF 1027A-O	1027.3
Hamilton Standard 33LF 1013A-O	1013.3

In each of the above Table Numbers the 3 after the decimal point indicates that a 3 bladed propeller is represented by the data in the table.

Hover data was previously input by specifying various propeller power coefficients for J=O (Loc 1702) and an input C_T (Loc 1723). The current modification enables the user to directly input Figure of Merit for specified C_T/σ and Tip Mach Number. Values of C_T/σ are input locations 2352-2361. M_{Tip} is input locations 2363-2368, and Figure of Merit is tabularized in locations 2369-2428. The user will no longer input the first advance ratio (Loc 1702) as J=O, or an error message will be printed out.

npIND=2 - Through use of this option the program will automatically calculate the performance of a wide variety of V/STOL propellers. The user need only specify the number of blades (3 or 4), the activity factor per blade, and the integrated lift coefficient, C_{L_i}. The method used for the calculation of propeller performance is the "short method" originated at the Curtiss-Wright Corporation's Propeller Division (Reference 6). The method involves the use of a set of equations which can be developed from strip theory. These equations permit the propeller performance maps (C_P, C_T, J) to be transformed into an "equivalent" lift-drag polar for the propeller. Conversely, the lift-drag polars, once developed, can be used with the equations to predict the propeller performance. For incompressible flow, the "equivalent" lift-drag polar which is used depends only on the value of C_{L_i} being considered. That is, for a given C_{L_i} the same polar can be used to accurately represent the performance of props with a wide variation in activity factor and number of blades and for a wide range of C_P and J. For compressible flow conditions, the curves correlate very well on the basis of the value of helical Mach number at the 3/4 radial station. The equivalent lift-drag polars which are contained in the program were developed from detailed strip analysis calculations for cruise and from calculations using an explicit vortex-influence technique in hover. These detailed calculations covered the following range of parameters:

No. of blades: 3 and 4
Activity factor/blade: 60 → 220
Integrated lift coefficient, C_{L_i}: 0.15 → 0.7

Although the user is permitted to input values of activity factor and C_{L_i} greater than (or less than) those shown above, the level of confidence in the predictions is reduced when values for those parameters are outside the range used in the detailed calculations.

Figures 4-15 and 4-16 are characteristic of the level of accuracy obtained from the short method when compared to the detailed calculations.

This option will calculate the propeller performance for all mission performance segments except Descent (SGTIND=5). For Descent, the user inputs a value for η_{p5}. Figure 4-17 is a flow chart of subroutine THRUST which calculates the propeller thrust available for known values of power and flight speed. Figure 4-18 is a flow chart for subroutine POWER in which the power required for specified thrust and flight speed is calculated. These subroutines make use of propeller equivalent lift-drag polars, as mentioned above, to calculate the performance of the propeller. The polars are developed in the main control loop for the particular value of integrated lift coefficient, C_{L_i}, being studied from the following equations:

$\gamma = \tan^{-1}(C_D/C_L)$ = function of M_H, C_L, C_{L_i}
M_H = helical Mach no. @ 3/4 r/R
C_L = equivalent lift coefficient at which prop is operating
C_{L_i} = integrated lift coefficient of prop

For cruise

$$\gamma = a_o + a_1 C_{L_i} + a_2 C_{L_i}^2$$

a_o, a_1, and a_2 are coefficients stored in the program and are functions of M_H and C_L

For hover:

$$\gamma = b_o + b_1 C_{L_i} + b_2 C_{L_i}^2$$

b_o, b_1, and b_2 are coefficients stored in the program and are functions of C_L.

The coefficients a_o, a_1, a_2, b_o, b_1, b_2 are listed in Table 4-3.

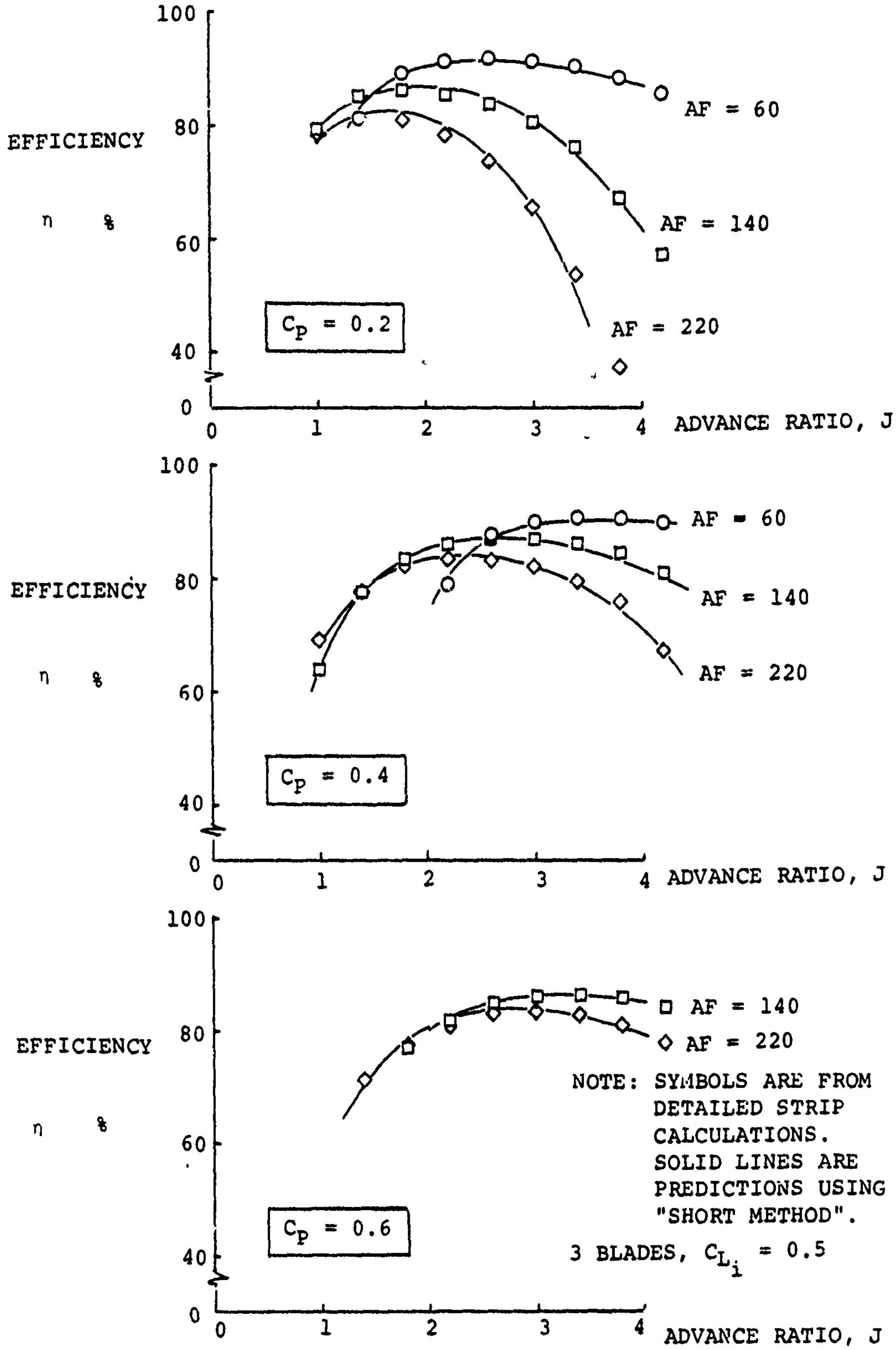


Figure 4-15. Comparison of "Short Method" and Detailed Calculations for Propeller Cruise Efficiency.

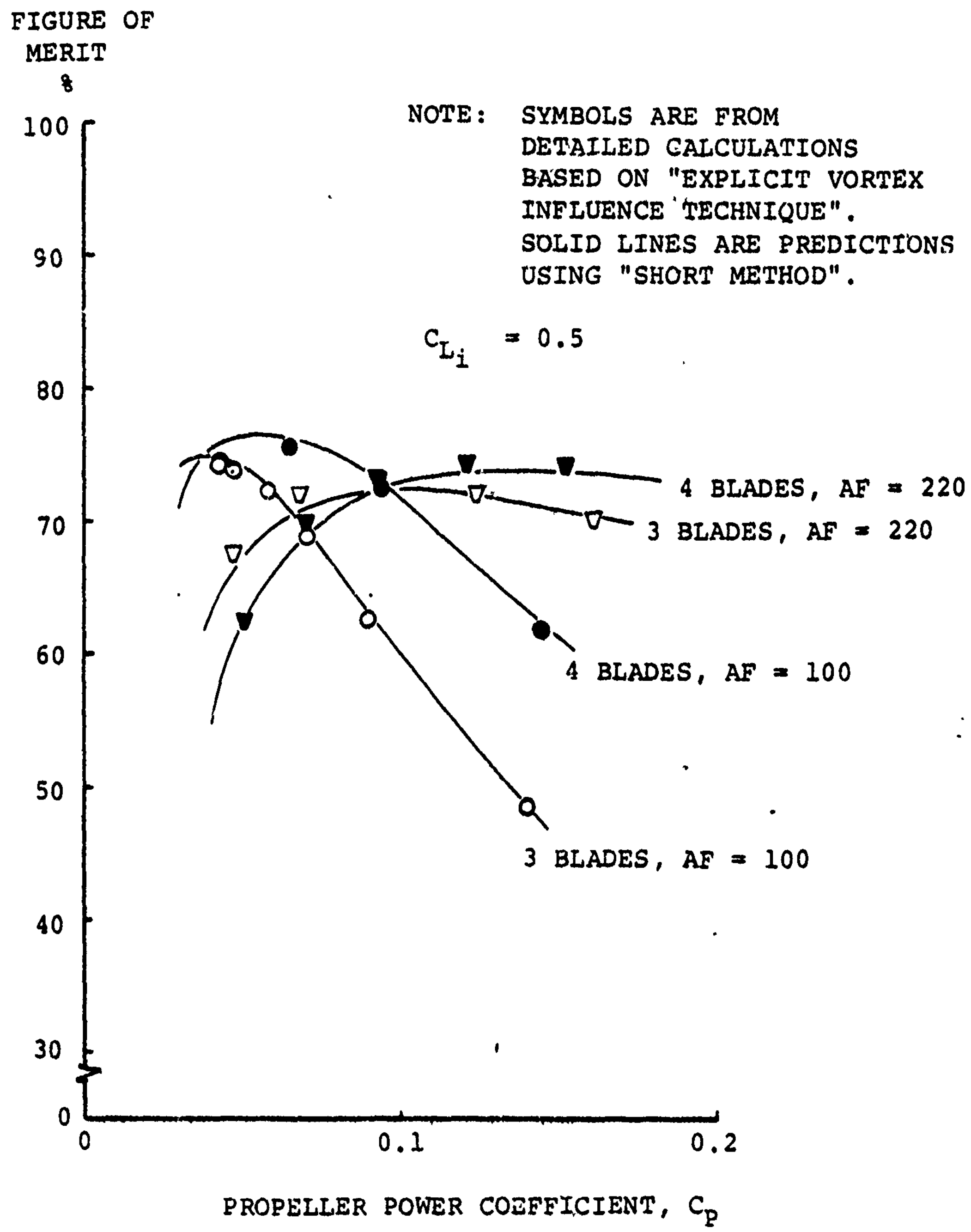


Figure 4-16. Comparison of "Short Method" and Detailed Calculation for Propeller Hover Efficiency.

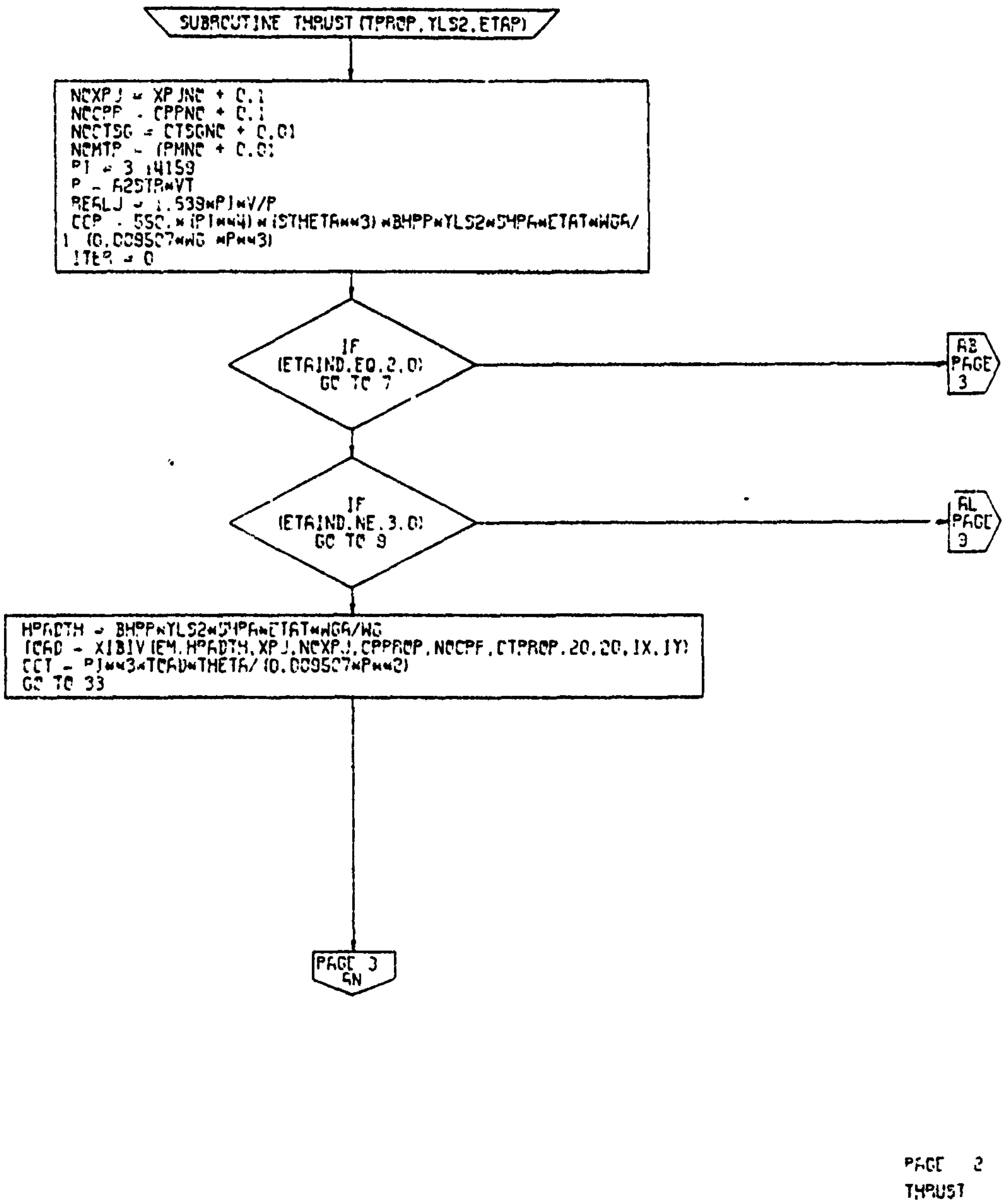


Figure 4-17. THRUST Subroutine, Flow Chart (Part 1 of 7)

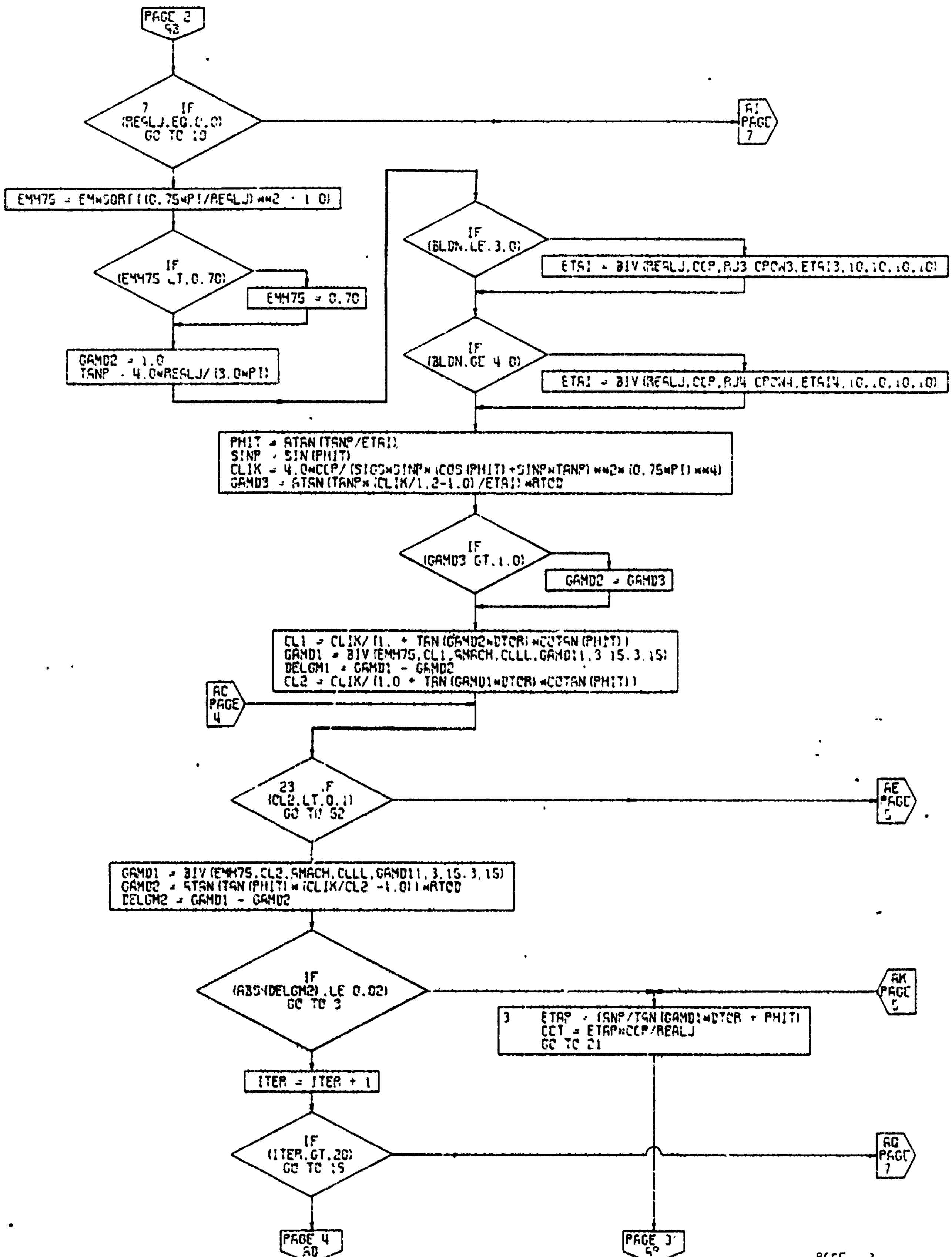


Figure 4-17. THRUST Subroutine, Flow Chart (Part 2 of 7)

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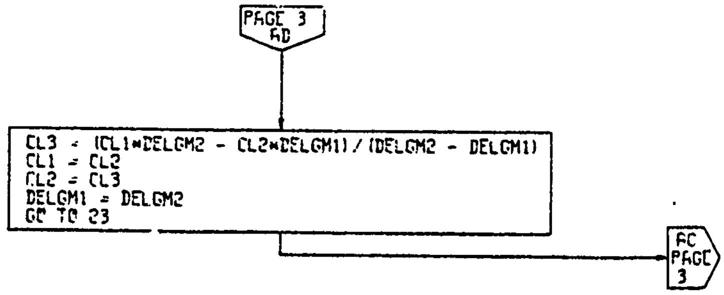
THRUST



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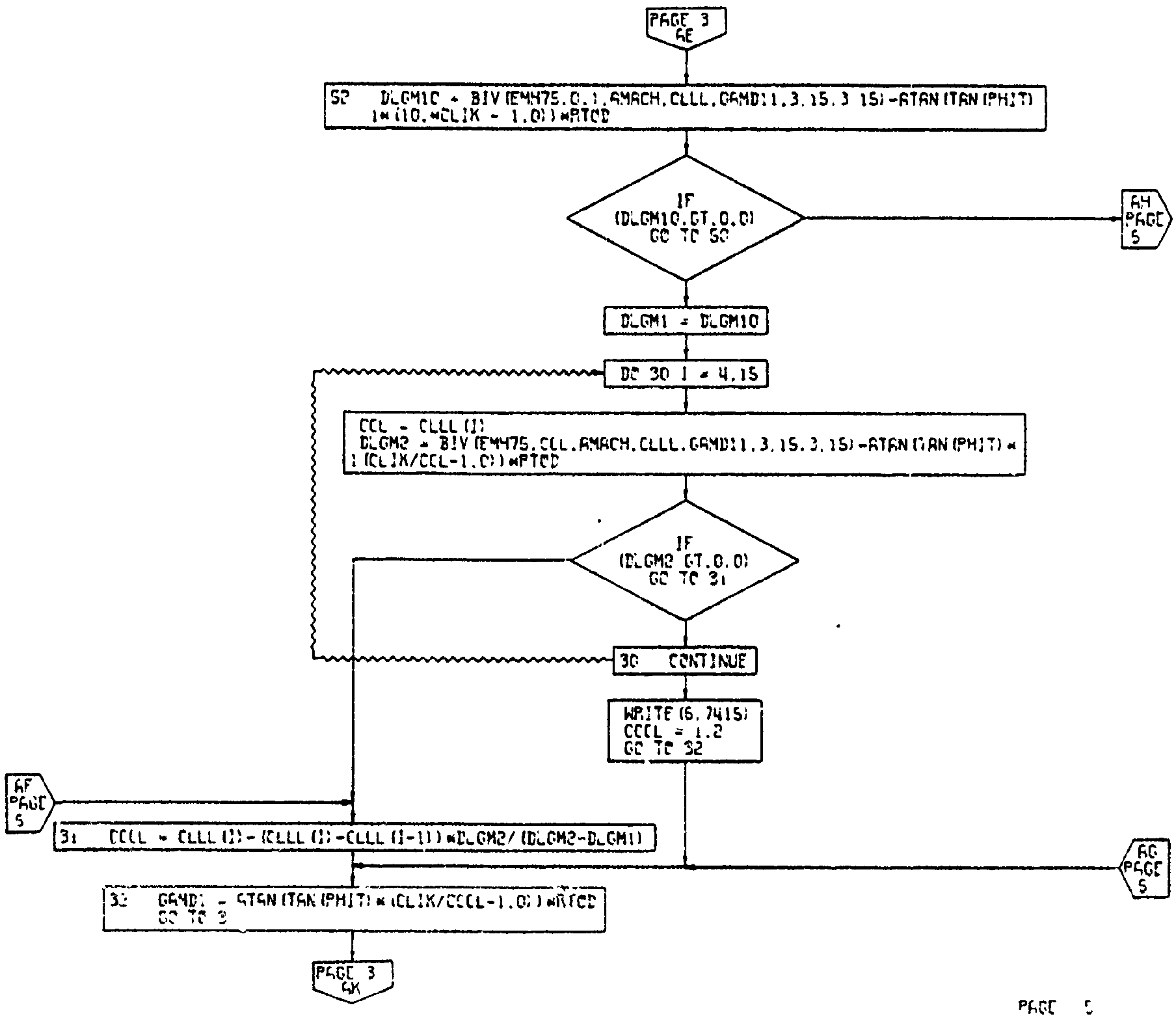

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Figure 4-17. THRUST Subroutine, Flow Chart
(Part 3 of 7)

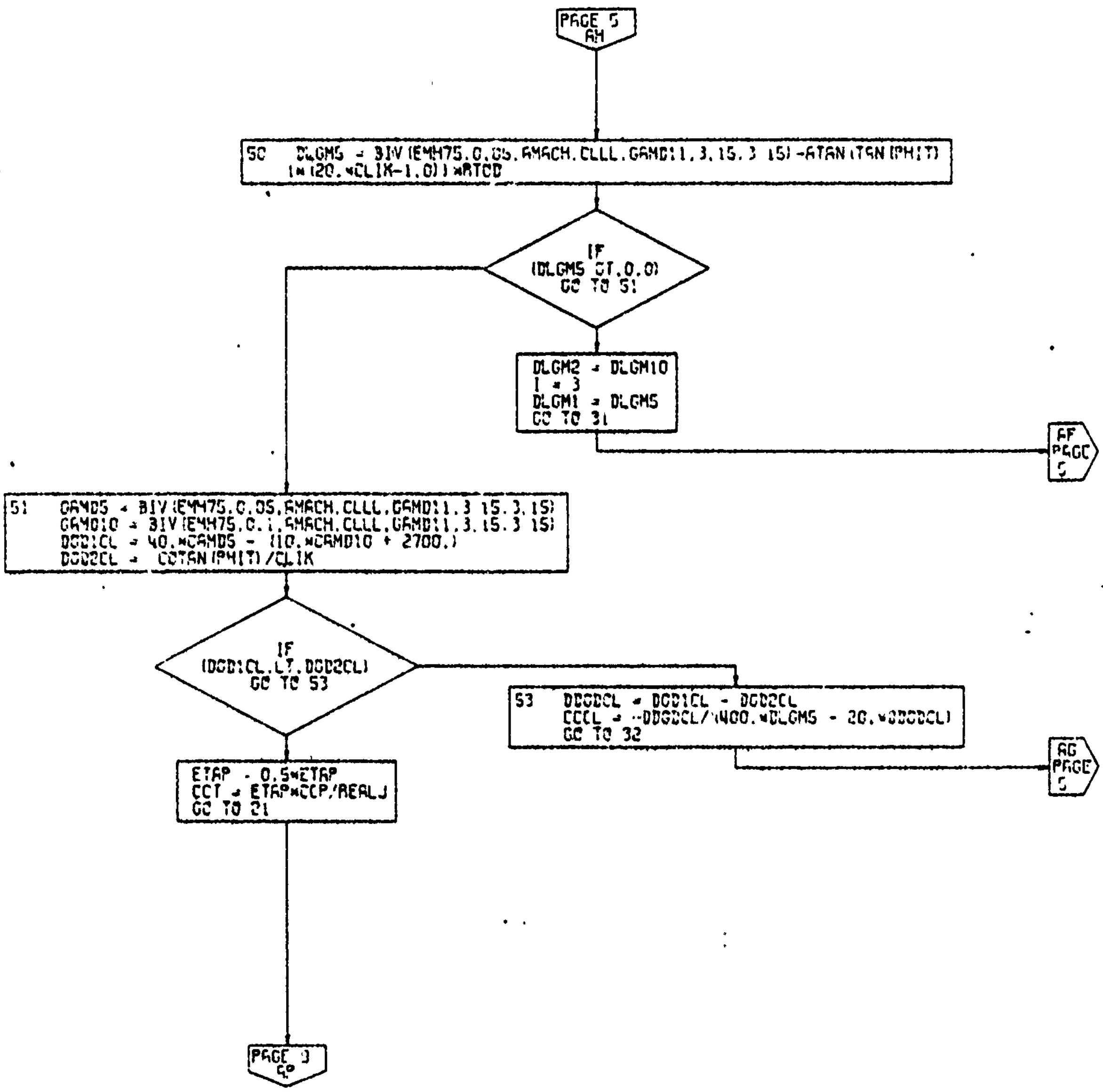

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Figure 4-17. THRUST Subroutine, Flow Chart
(Part 4 of 7)

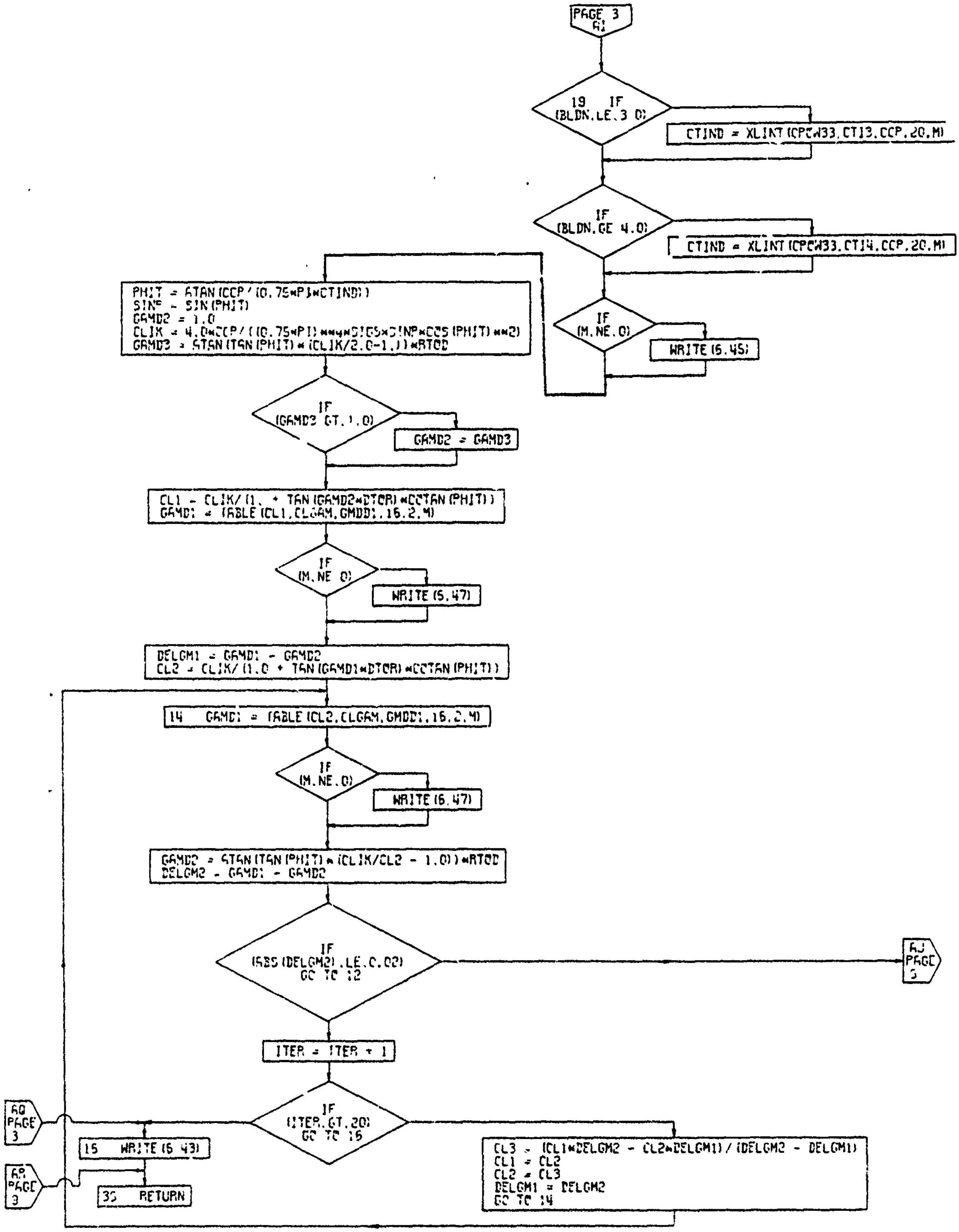

Figure 4-17. THRUST Subroutine, Flow Chart (Part 5 of 7)

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THRUST

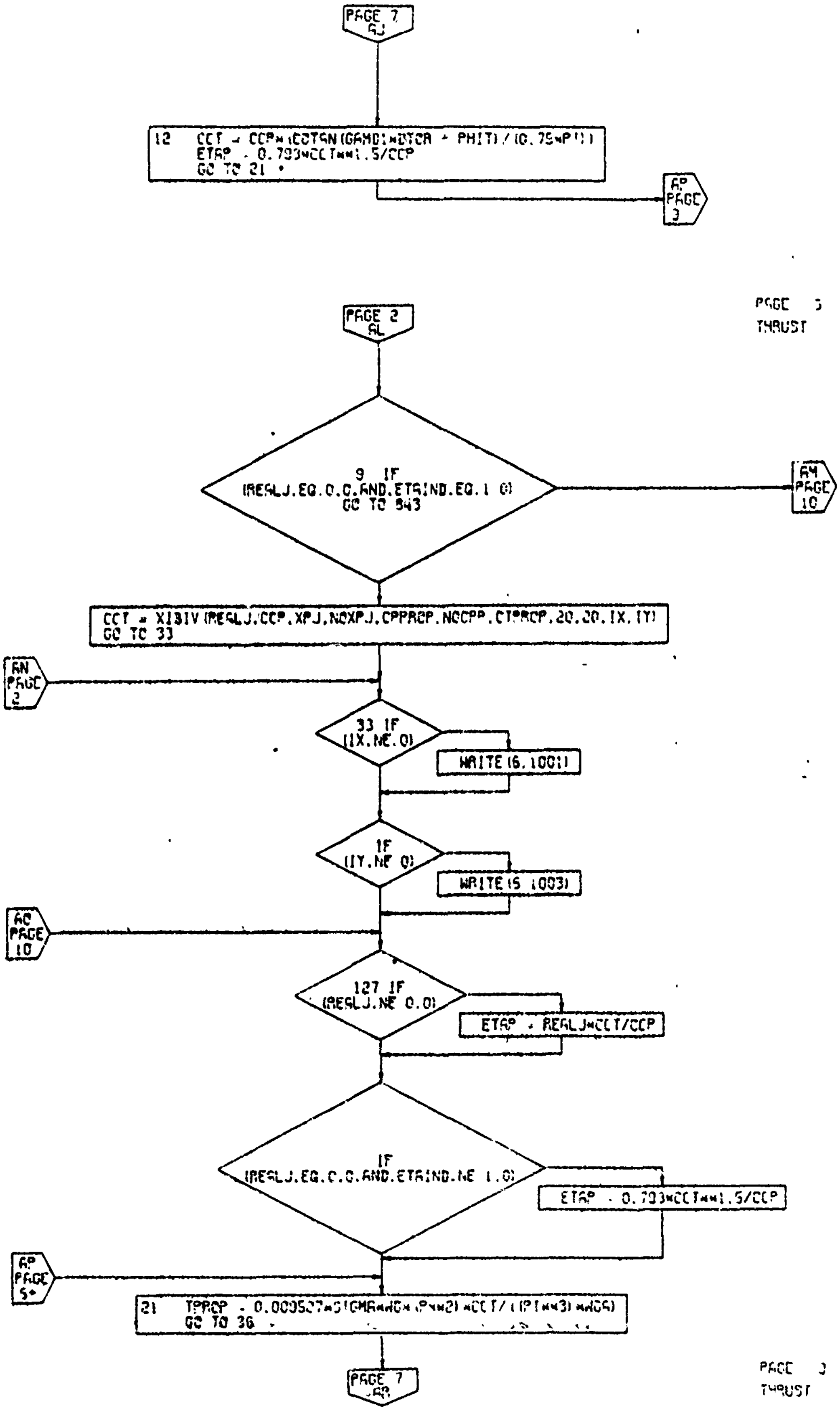

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Figure 4-17. THRUST Subroutine, Flow Chart (Part 6 of 7)

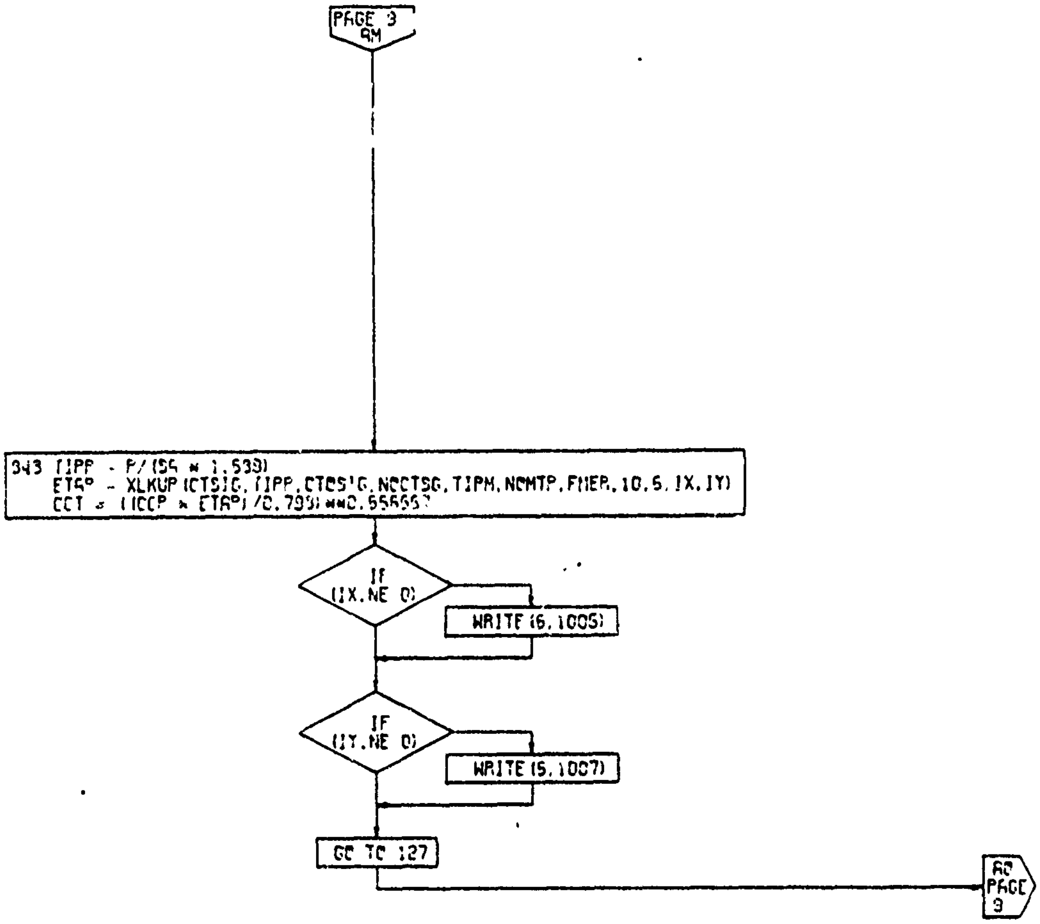

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Figure 4-17. THRUST Subroutine, Flow Chart (Part 7 of 7)

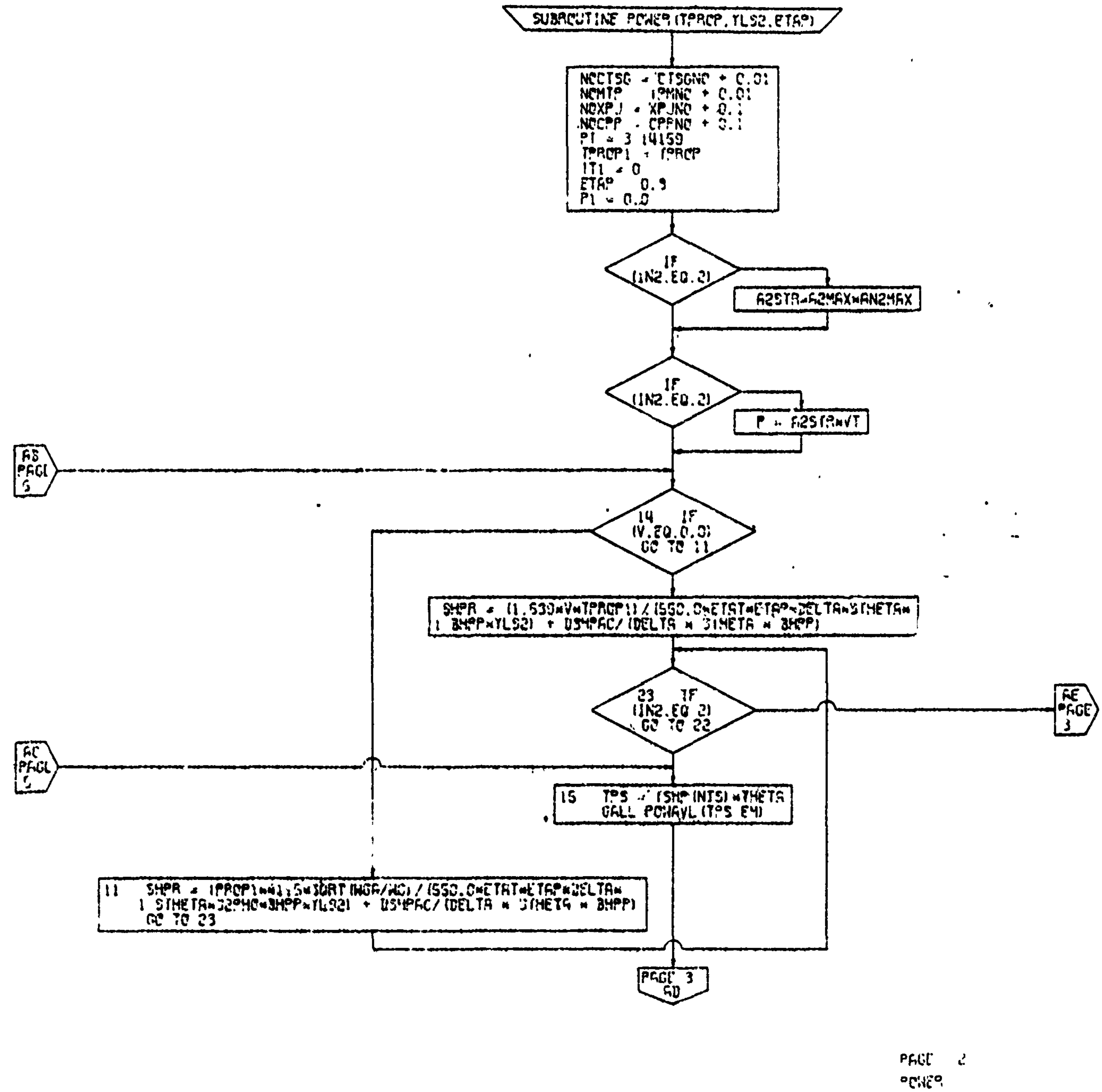
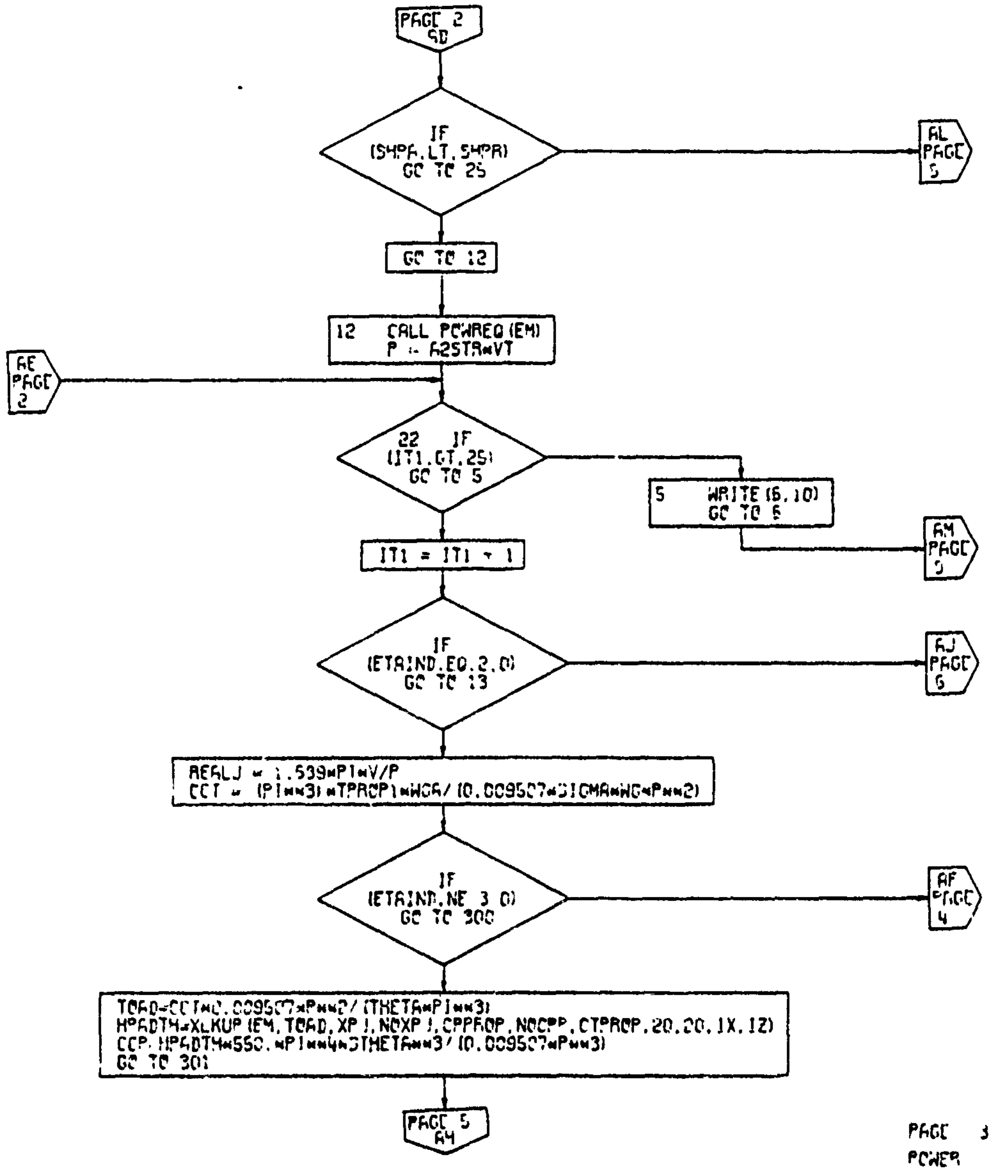


Figure 4-18. POWER Subroutine, Flow Chart
(Part 1 of 5)



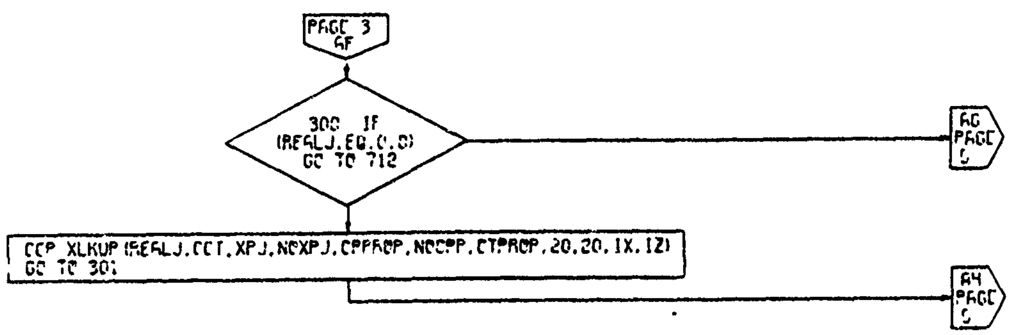


Figure 4-18. POWER Subroutine, Flow Chart (Part 2 of 5)

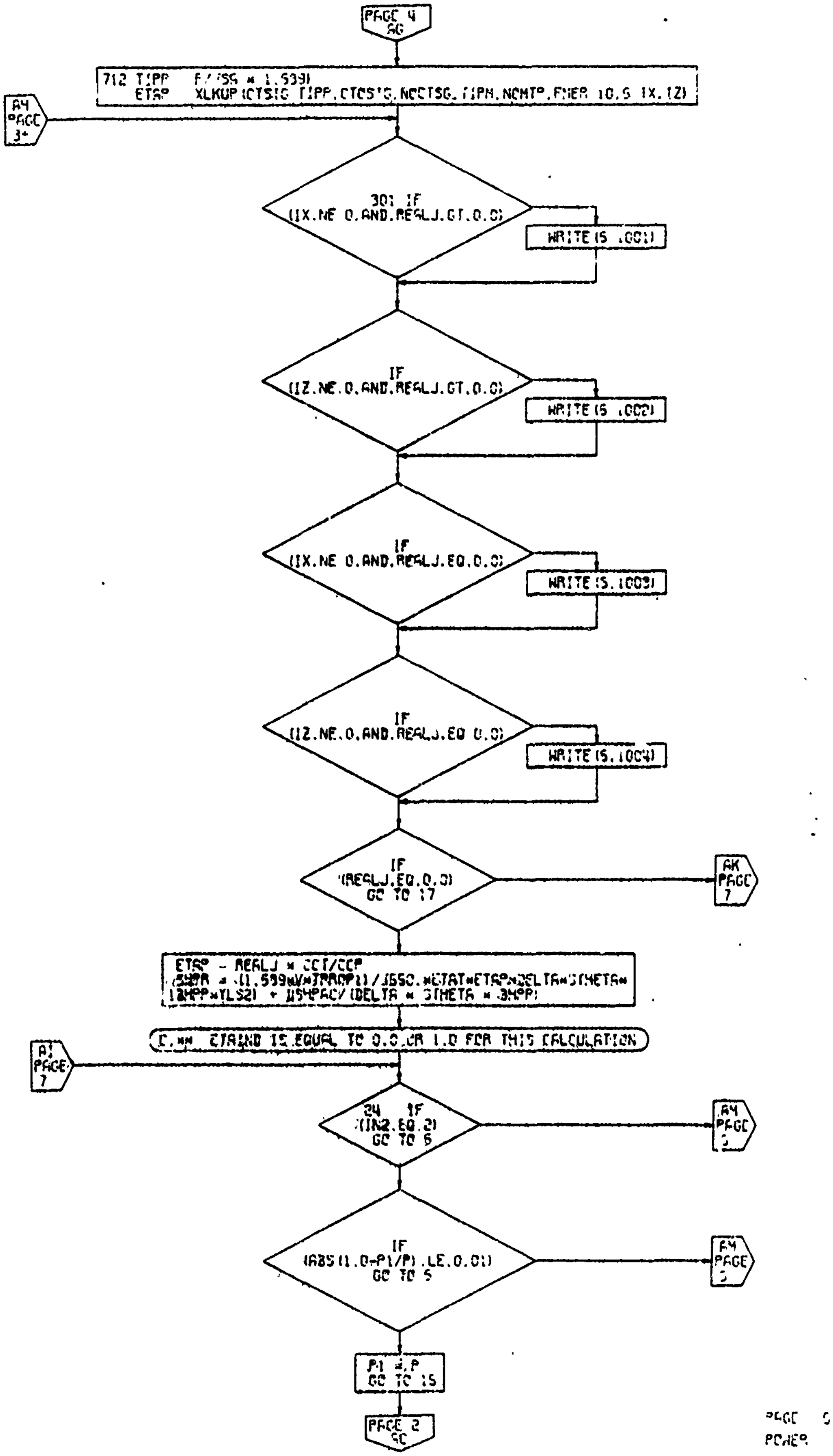
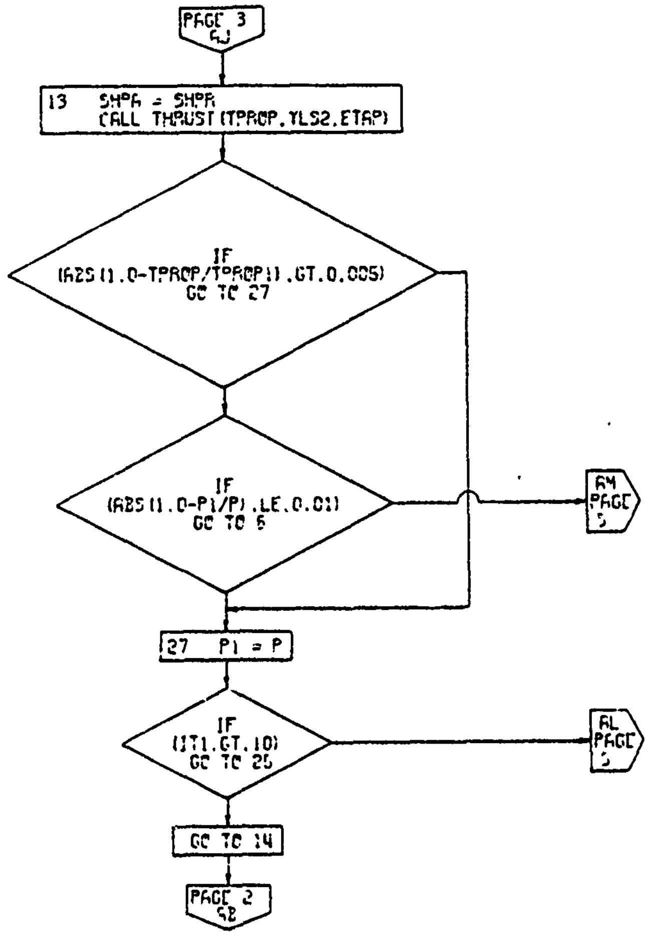


Figure 4-18. POWER Subroutine, Flow Chart (Part 3 of 5)



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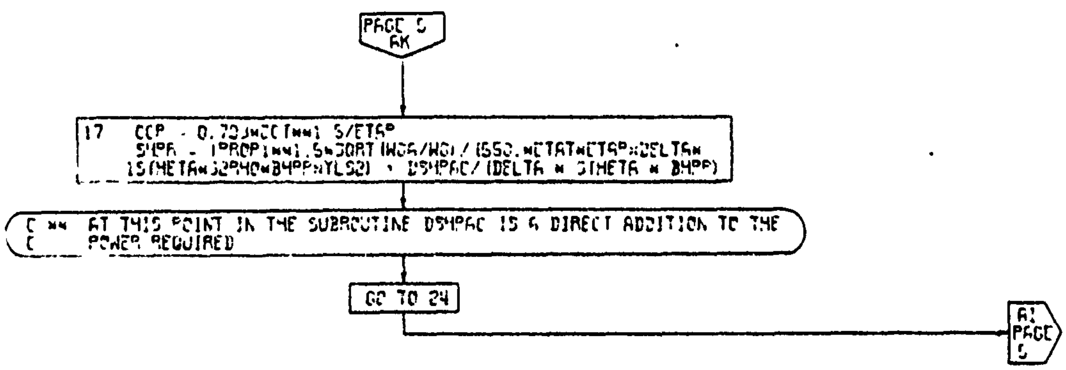

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Figure 4-18. POWER Subroutine, Flow Chart
(Part 4 of 5)

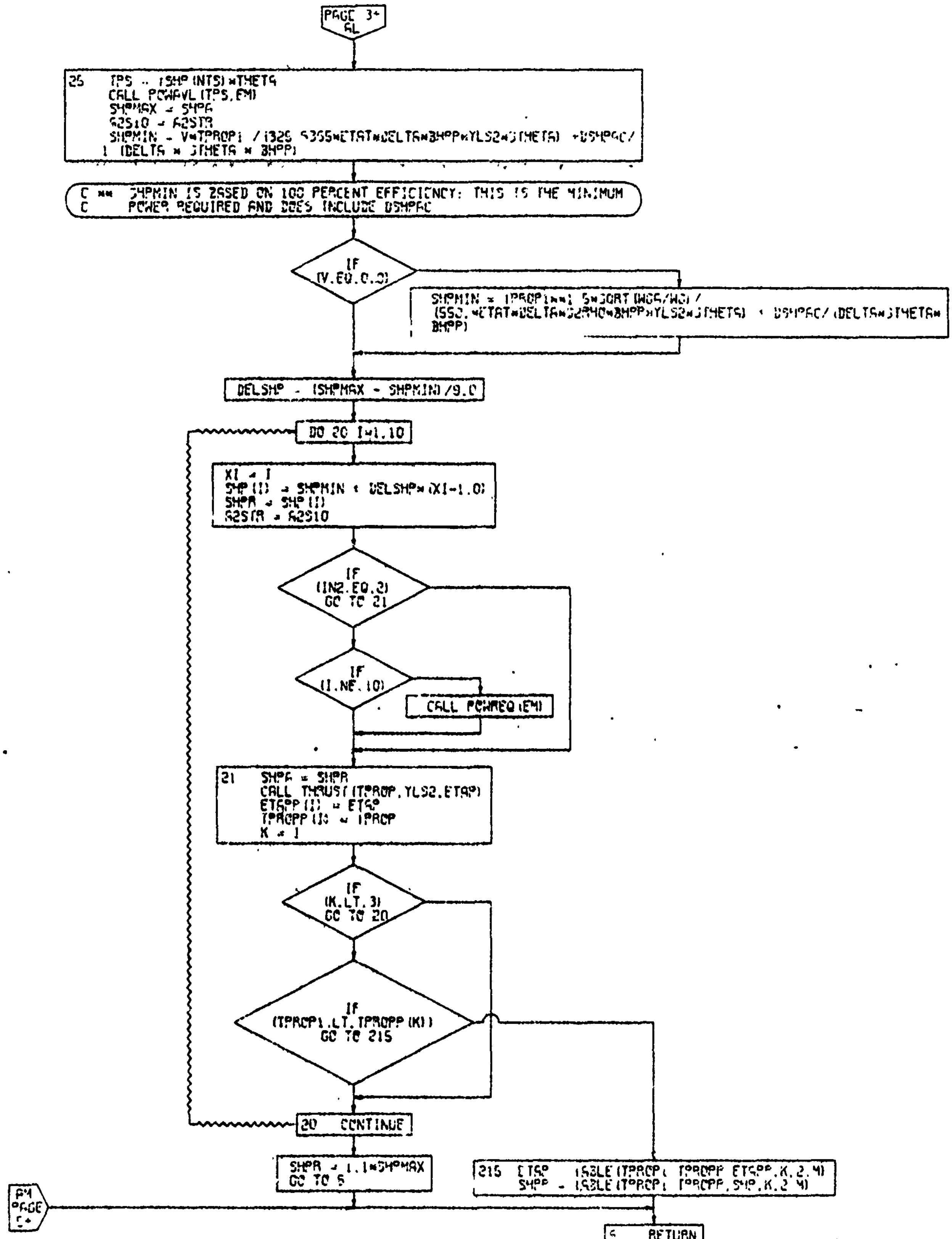

Figure 4-18. POWER Subroutine, Flow Chart (Part 5 of 5)

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POWER

TABLE 4-4

COEFFICIENTS FOR PROPELLER EQUIVALENT POLARS

COEFFICIENTS FOR HOVER:

C_L	b_1	b_2	b_3
0	90	0	0
.15	2.68	-5.4836	13.5125
.2	1.9141	-2.5393	8.012
.3	1.513	-2.7523	5.8118
.4	1.5304	-3.0648	4.8132
.5	1.9611	-4.5374	5.3846
.6	2.7089	-6.8293	6.8072
.7	3.8237	-10.0965	9.3267
.8	5.051	-12.558	10.7333
.9	7.3796	-18.5171	15.8002
1.0	9.13	-19.35	15.5

COEFFICIENTS FOR CRUISE:

C_L	M_H	a_0	a_1	a_2	M_H	a_0	a_1	a_2	M_H	a_0	a_1	a_2
0	0.7	90.	0.	0.	0.8	90.	0	0	0.9	90.	0.	0.
.05		7.0392	1.9949	61.2416		10.2148	2.4433	86.4731		11.3227	40.9515	21.9481
.10		4.8350	-4.1639	19.2195		8.3106	-22.6338	56.0		11.3355	-14.062	62.0142
.15		3.2218	-1.7030	8.291		5.4623	-14.9997	35.3636		8.3676	-12.2425	36.0889
.20		2.7551	-2.5322	7.0366		4.0458	-9.9837	23.0606		6.5856	-9.574	25.9573
.3		2.481	-4.5422	7.3774		3.9439	-13.0524	22.0028		5.3862	-8.9808	18.6439
.4		2.4521	-5.4949	7.4251		3.6769	-11.7146	17.3803		5.2054	-9.3153	16.4063
.5		2.8149	-7.092	8.3401		3.8766	-12.0044	16.0882		6.1902	-14.7567	23.2672
.6		3.8725	-10.861	11.4678		4.5901	-13.8756	17.2451		8.153	-25.0375	39.117
.7		5.6653	-16.2691	15.8093		6.1044	-18.2607	21.8349		10.1745	-30.7342	51.0509
.8		8.5799	-24.8115	22.6773		8.9031	-26.0958	30.7056		13.0822	-33.2211	58.1494
.9		12.25	-33.6185	28.7271		12.2042	-29.4588	34.1515		16.5344	-34.9378	64.3529
1.0		17.0496	-43.061	33.8798		17.0398	-37.3809	43.697		20.8089	-40.6314	76.3927
1.1		21.8332	-47.8821	33.6322		22.784	-47.3791	55.5455		25.6453	-49.145	94.4326
1.2		31.7062	-49.6246	26.4923		28.7851	-57.8217	68.2121		33.5049	-77.6449	144.4176

The calculations of propeller performance for η_pIND = 1 and 2 are based on the assumption that the engines are interconnected by a cross shaft. That is, if engines are shut down during cruise and loiter the remaining power is evenly distributed to all of the propellers.

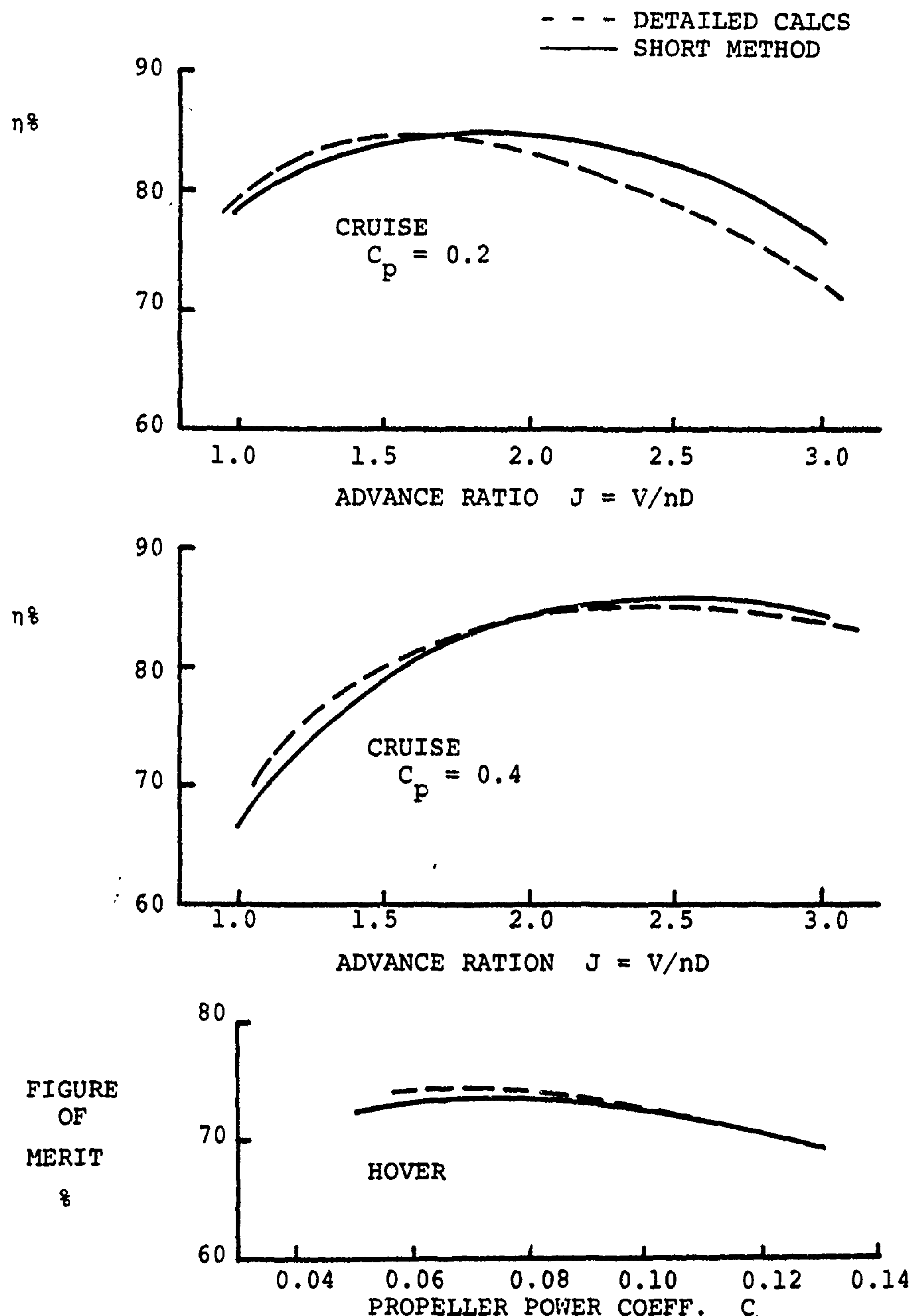
Accuracy of Propeller Performance Calculation for η_pIND = 2.0

The propeller performance calculation subroutine using the Curtiss-Wright (modified) Short Method has a data base derived from extensive detailed calculations for a family of high disc loading V/STOL propellers. In order to confirm that the subroutine accurately represents the performance of this type of propeller, the comparison of Figure 4-19 was made between the "short method" calculation and detailed calculations for the propeller of the Vertol Model 170-544P tilt wing transport airplane. The prediction is very good and properly reflects the compromise between hover and cruise performance.

Figure 4-20 shows a comparison between the subroutine and a comparable data base for propellers specifically designed for cruise applications. The data were obtained from the Hamilton Standard "Red Book." Such propellers would be designed with a greater amount of twist than a V/STOL propeller and consequently the data base of the propeller calculation subroutine may not be expected to give accurate predictions in this case. However, as shown in Figure 4-20, the subroutine predicts cruise efficiency only slightly lower than the Red Book and exhibits the same trends.

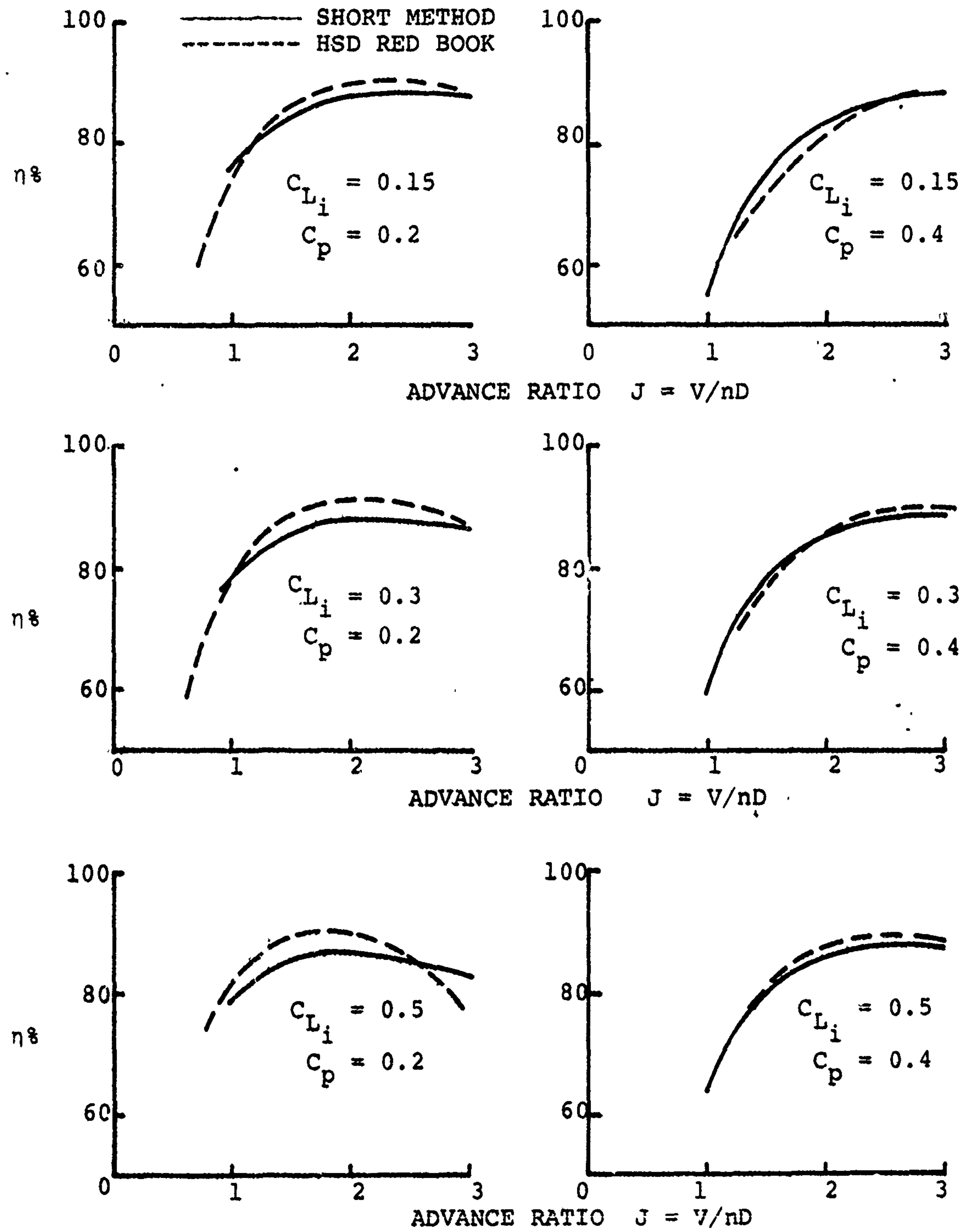
As an additional comparison, the subroutine has been used in an attempt to predict the performance of a low disc loading prop-rotor. Because of the relatively small amount of blade twist associated with the low disc loading prop-rotor the data base used in the subroutine does not result in accurate performance predictions. This is shown in Figure 4-21 where the subroutine calculations are compared with detailed calculations. As might be expected, the subroutine underpredicts hover performance and overpredicts the cruise performance for this propeller.

The data base for the subroutine was derived from detailed calculations for a family of moderate to high disc loading V/STOL propellers. A similar set of data could be prepared for other propellers, such as the low disc loading prop-rotor, which would allow accurate performance predictions by the subroutine for these propellers.



3 BLADES, C_{Li} = 0.52, AF = 100/BLADE

Figure 4-19.
V/STOL PROP FOR VERTOL MODEL 170- 544P TILT WING



4 BLADES, ACTIVITY FACTOR ≐ 100/BLADE

Figure 4-20. Comparison of Short Method vs Hamilton Standard Red Book Data

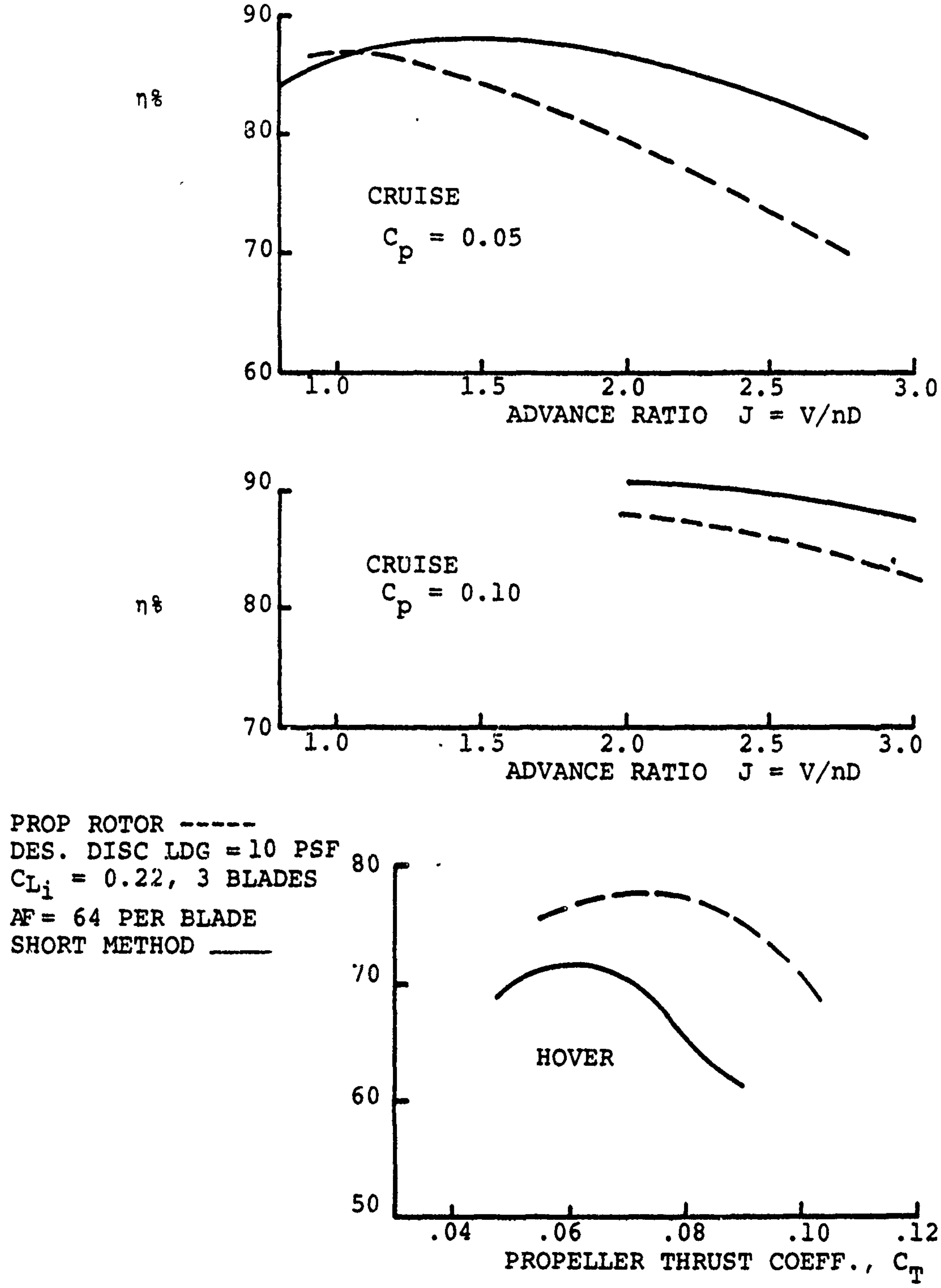


Figure 4-21. Performance Predictions of Low Disc/Loading Prop/Rotors

η_pIND = 3.0 This option allows the user to input a fan performance table similar to the propeller performance table used for η_pIND = 1.0. The ducted fan performance is supplied to the program in the form of a table of referred power as a function of forward flight Mach Number and referred thrust: $SHP/A_2\delta\sqrt{\theta}$ = (M, $TA_2\delta$) where A_2 is the annulus area of the fan.

To use the ducted fan option, the user must provide the following inputs:

• η_p IND = 3.	in LOCATIONS 0200
• Fan Table Number	in LOCATIONS 1700, 0256
• Number of Mach Numbers	in LOCATION 1701
• Number of Reffered Thrusts	in LOCATION 1722
• Tabulated Values of Mach Number	in LOCATIONS 1702 through 1721
• Tabulated Values of $T/A_2\delta$	in LOCATIONS 1723 through 1742
• Tabulated Values of $SHP/A_2\delta\sqrt{\theta}$	in LOCATIONS 1743 through 2142
• A zero input of $k_{R/p}$	in LOCATION 0457
• An appropriate value of kTM	in LOCATION 0408

The above data may be input using the Propeller/Fan data input sheets, and the Weights input sheet provided in Chapter 5.

No changes have been incorporated to caluclate the weight of ducted fan systems and it is considered that the weight equations associated with the propeller inputs would give an inaccurate estimate. To avoid using the propeller weights equations, $k_{R/P}$, LOCATION 0457, should be input as zero. The weight of a ducted fan system can be calculated by use of the variable input k_{TM}, which is nominally the weight factor for the tilt mechanism on a tilt wing or tilt rotor aircraft. This constant calculates a weight which is proportional to the aircraft gross weight. Since the weight of a ducted fan is approximately proportional to the design thrust and the design thrust is determined by a design thrust to weight ratio, choice of a suitable value for k_{TM} allows the user to obtain a reasonable estimate of the weight of the ducted fan system.

In propeller or rotor calculations within VASCOMP, the reference area employed is the total disc area and is calculated from inputs of either disc loading or diameter and the number of propellers or rotors. In order to obtain accurate values of A_2 for ducted fan calculations, the user must either (i) scale the fan performance data so that the reference area is A (the disc area) rather than A_2, the annulus area, or (ii) use input values of disc loading or diameter that will ensure that the calculated reference area is equal to the annulus area. Two options are available. When PDMIND (Location 0005) is 1 or 3, the user must input a "Diameter" in Location 0226. To make the reference area A (= $N_R\pi D^2/4$) equal to the annulus area of the fan, a value of D = $N(D_T{}^2-D_R{}^2)$ must be used, where D_T and D_R are the tip and root diameters of the fan, respectively.

In cases where PDMIND is 2 or 4, the user must input the "fan loading" (= W_G/A_2) in Location 0225 rather than disc loading. The calculated value of diameter will be the effective value, $N(DT^2-DR^2)$.

DISUCSSION OF PROPULSION EFFICIENCY

The final selection of a propeller blade design to best suit a given V/STOL aircraft mission is a rather arduous task because the suboptimization of many considerations such as propeller efficiency, propeller weight, power transmission system weight, powerplant performance, and others is required for each mission segment followed by an overall mission optimization. A single propeller design does not satisfy the requirements for optimum performance in every mission segment. That is, the design optimized for best hovering performance is not also the best climb or cruise segment design.

The basic problem faced in evolving a single propeller design to satisfy all flight conditions is that of achieving the optimum blade loading for each of the flight conditions. This is virtually impossible due to the degree and manner in which thrust required and power available vary with engine and vehicle speeds. From an aerodynamic viewpoint, this basic problem manifests itself in terms of problems associated with blade chord, twist and design C_{L_i} distributions, engine-propeller performance matching, and compressibility.

Propeller blade loading is a function of the spanwise distribution of blade twist, blade chord, and blade section design lift coefficient. These three parameters must be employed so as to yield the optimum propeller performance at a given flight condition. This will occur when each section of the blade is adjusted to operate at or near its maximum lift-drag ratio while maintaining an optimum spanwise load distribution. As the operating conditions vary, the degree to which near optimum conditions can be maintained changes for a fixed blade geometry. Therefore, some compromise must take place, and best efficiency cannot be achieved at each and every operating condition.

As one can appreciate, with fixed blade geometry the attainment of overall propeller optimization is somewhat limited with regard to what can be aerodynamically achieved with twist, solidity, and design lift coefficient. Furthermore, changing these variables results in variations in blade centrifugal twisting moment, hub centrifugal loads, blade pitch control loads, and numerous other items which result in either operational envelope limitations or weight constraints. Variable blade geometry can result in aerodynamic improvements, but these may well be offset by increased weight and cost. Variable geometry

propeller blade development and application, furthermore, have been quite limited.

The ability to alter propeller speed in cruise with respect to hover will help the designer cope with blade loading problems and result in better mission efficiency. This can be done either by using a multiple speed power transmission system between the engine and propeller or by exercising the variable output shaft speed capability of free turbine powerplant. The former method is generally not used due to weight penalties, while the latter method is extensively employed. Engine-propeller matching, though, is not as simple as it may sound, and transmission torque requirements and weight increase with reduced turbine speed.

The combination of vehicle speed, propeller speed, diameter and altitude produce a constraint in the form of Mach number. Exceeding a helical tip Mach number of about 0.95 appears to significantly reduce propeller efficiency.

Current state of the art regarding propeller aerodynamics appears to permit very accurate appraisal of a given propeller design's performance over most of the flight envelope. Performance prediction capability is generally inadequate in the following areas: (1) static thrust (e.g., relating to the pure hovering flight mode), (2) at moderate to high propeller shaft angles of attack (say 30 to 90 degrees), and (3) under the "mixed" flow conditions where the blade sections are in neither wholly subsonic nor wholly supersonic flows. For purposes of preliminary design, however, the short methods for predicting propeller performance available from propeller manufacturers (e.g., Curtiss-Wright and Hamilton Standard) generally produce acceptable results, and should certainly be given consideration.

Whenever possible, the aircraft designer should consult the propeller manufacturers and his own propeller staffs early in the preliminary design phase. Lacking this, he should freely exercise the methodology published by propeller manufacturers. These methods require only several minutes to manually compute a propeller performance point and are well worth the effort. Too many preliminary aircraft designs have proceeded too far assuming propeller efficiencies in excess of the ideal induced (i.e., zero drag) value.

4.6 SIZE TRENDS SUBROUTINE

The size trends subroutine calculates the trends of the aircraft geometric dimensions as the weight of the aircraft changes throughout the iterative sizing loop. Figure 4-22 displays a flow chart showing the several options available within the size trends subroutine. The first of these is an option concerning the calculation of fuselage dimensions. The fuselage dimension option is specified by means of the input indicator FDMIND, the fuselage dimension indicator. This option permits the user to either input the length and wetted area of the fuselage or to have the program calculate these factors. If FDMIND = 1, the computer program will calculate the length and wetted area of the fuselage based upon input values of the cabin length, the cabin mean diameter, and the fineness ratio of the pilot's section and the tail section. If FDMIND = 0, the length of the fuselage and wetted area are input to the program by the user. This option is included in the program so that the user studying an aircraft of known fuselage dimensions can input the exact dimensions to the program.

If the fuselage dimension indicator is set to 2, the airplane fuselage will be sized to accommodate specified passenger requirements. The user inputs the required number of passengers, seats abreast, number of aisles, unit seat width, seat pitch, and aisle width. This data can be input for both first class and tourist service. Two different options are available for galleys and lavatories. Each is specified by means of an input indicator. Setting the galley indicator and/or lavatory indicator to 1 will permit the user to directly specify the galley area and/or the number of lavatories. A zero (0) input will force the program to use the following built-in trends:

Lavatories

No. of Passengers	No. of Lavatories
0 → 59	1
60 → 99	2
100 → 139	3
140 → 179	4
etc.	etc.

The floor area required for lavatories is calculated at 16 square feet per lavatory.

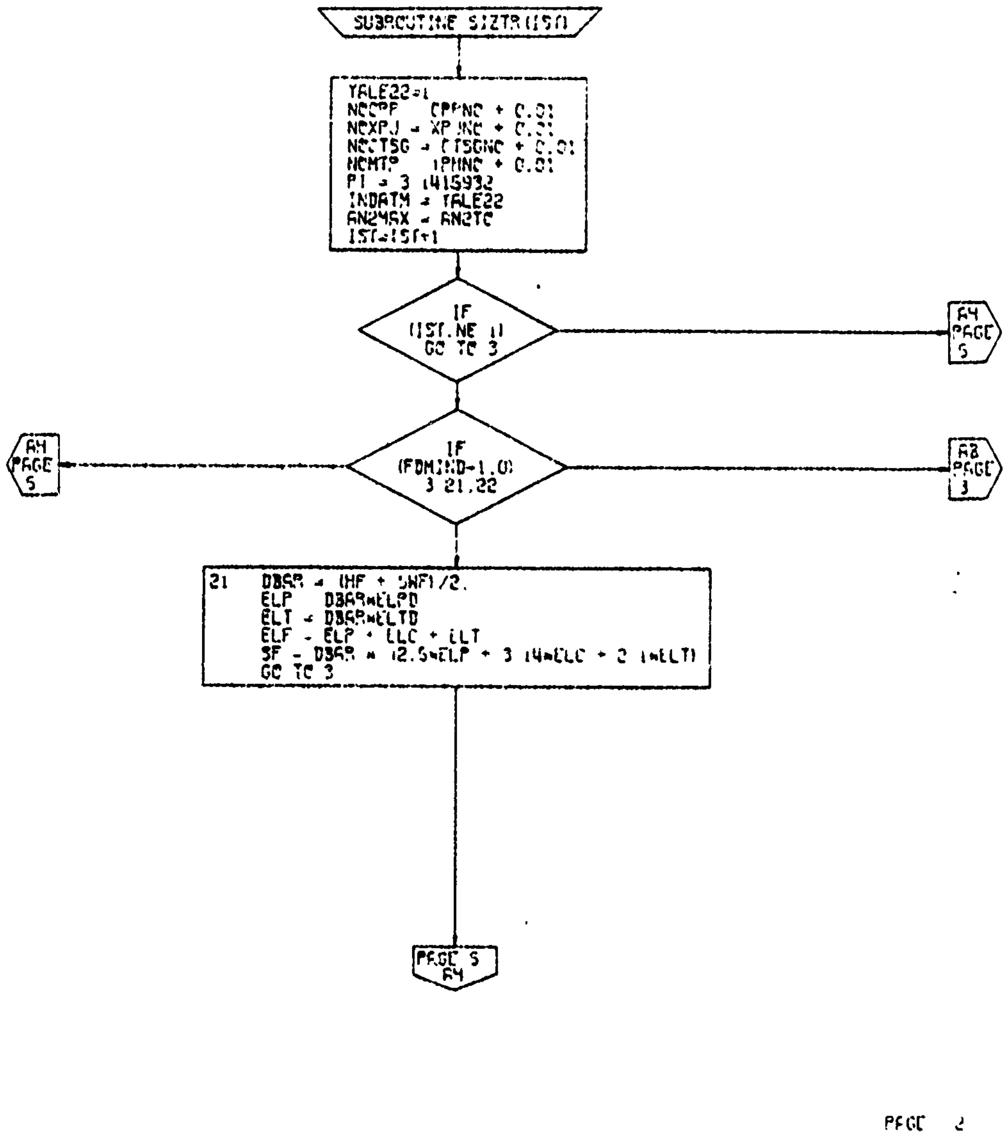


Figure 4-22. Size Trends Subroutine, Flow Chart (Part 1 of 13)

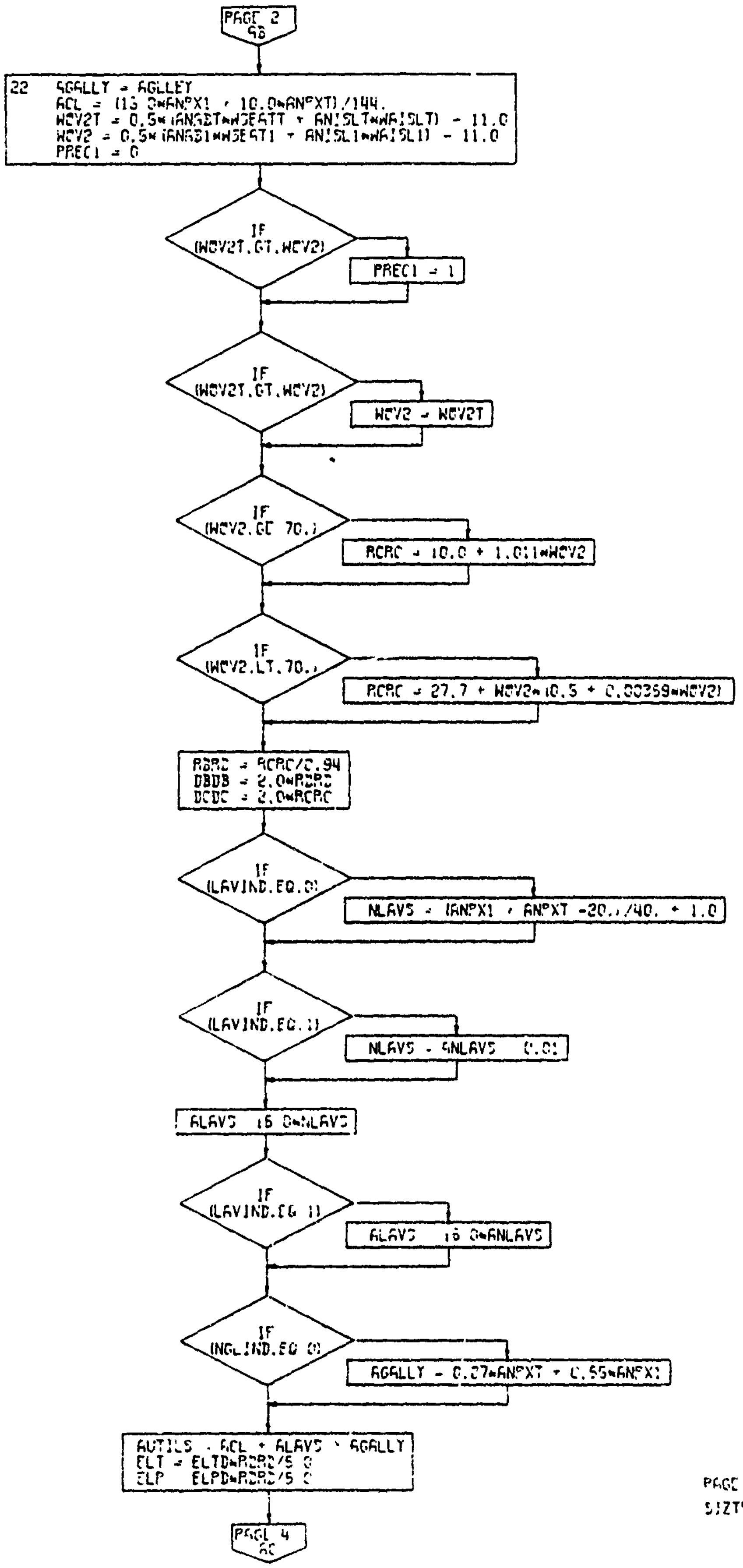


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Figure 4-22. Size Trends Subroutine, Flow Chart (Part 2 of 13)

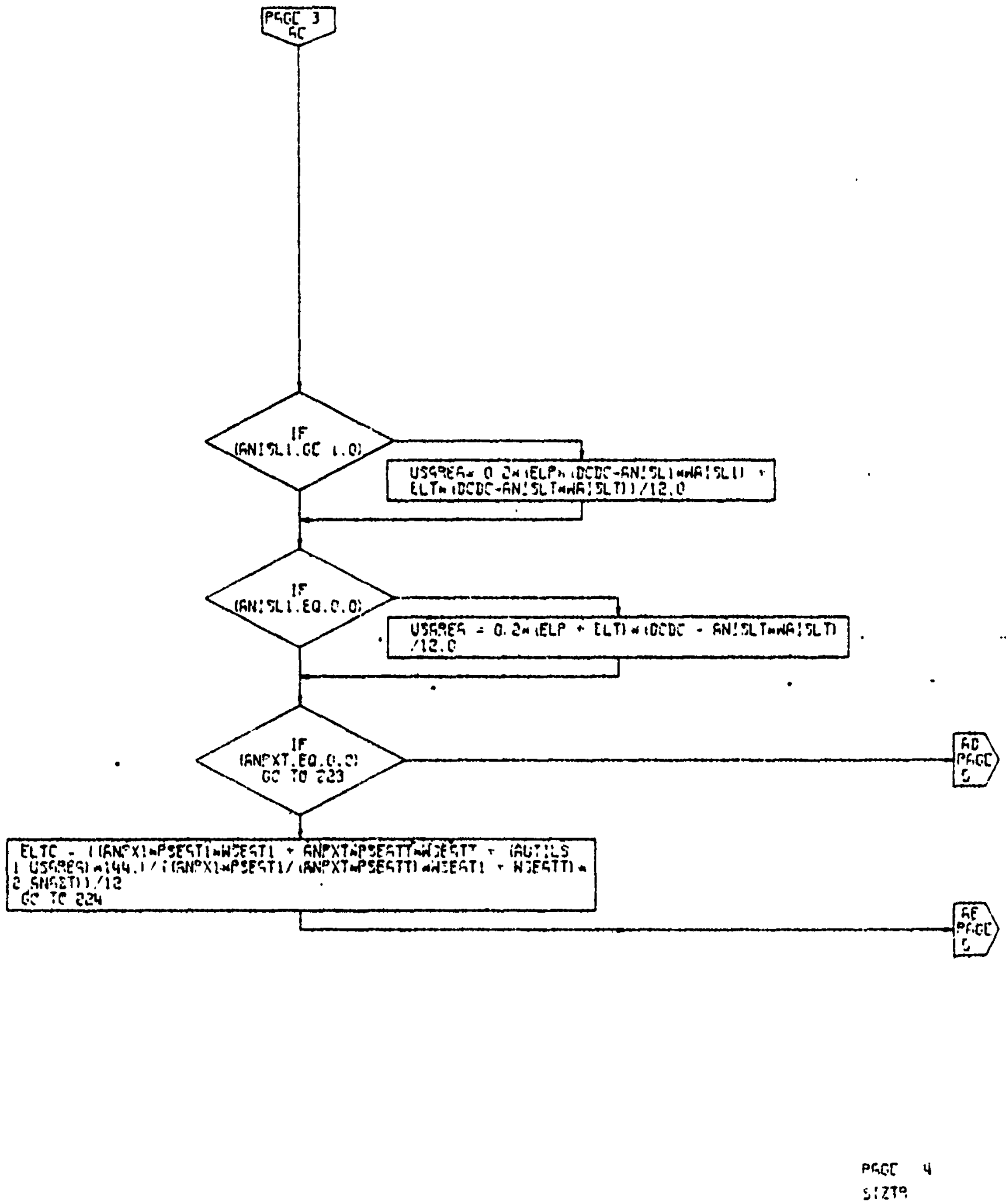


Figure 4-22. Size Trends Subroutine, Flow Chart (Part 3 of 13)

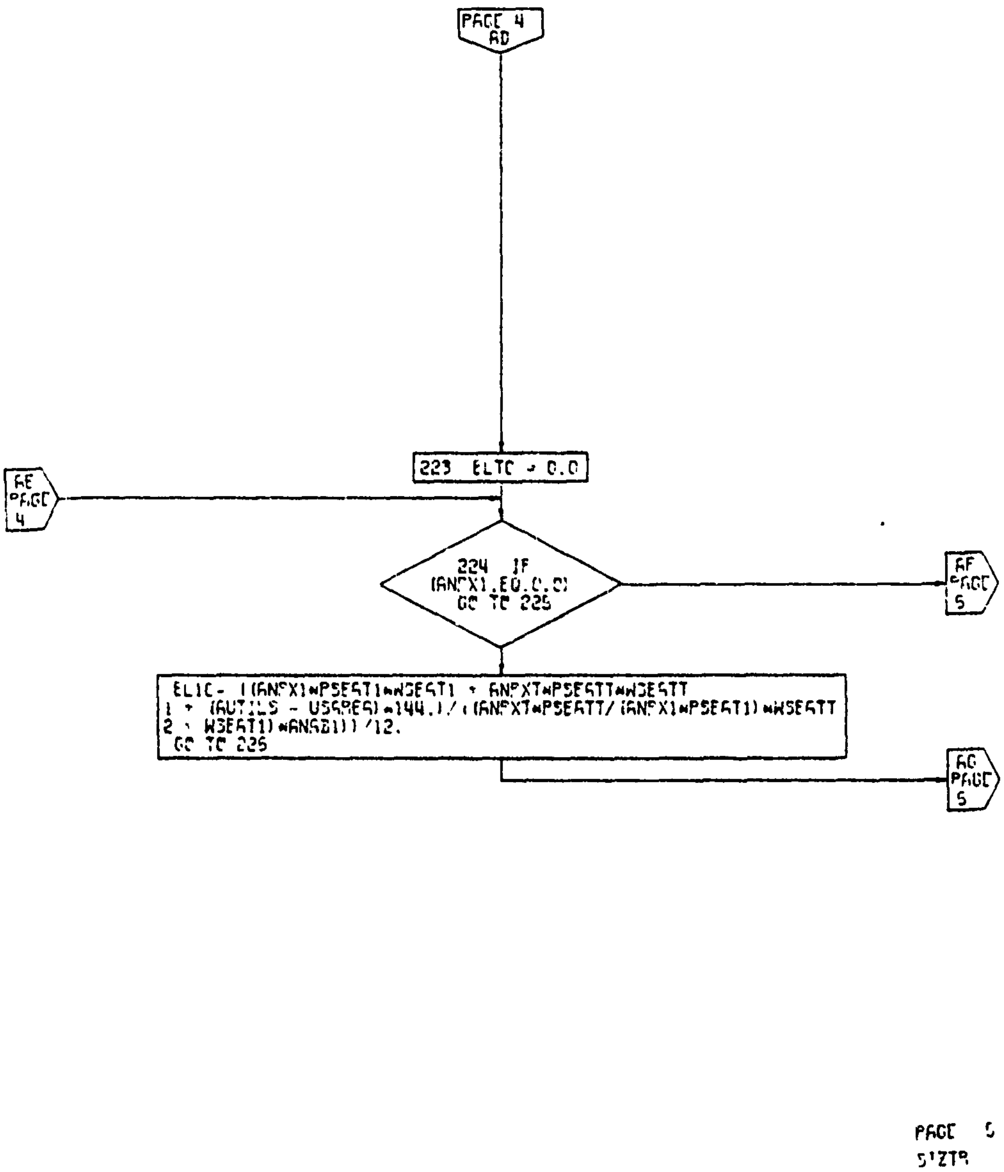


Figure 4-22. Size Trends Subroutine, Flow Chart
(Part 4 of 13)

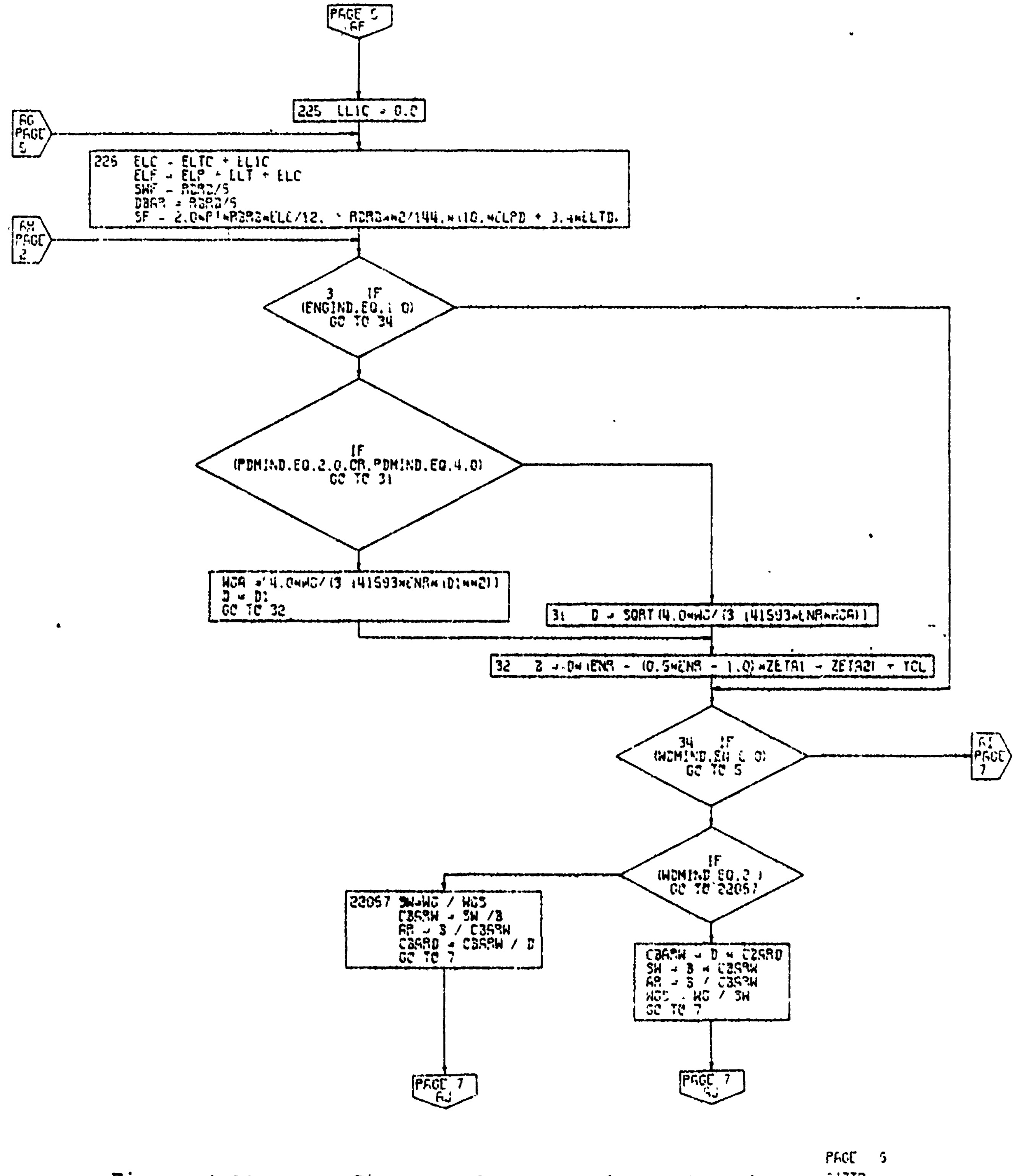


Figure 4-22. Size Trends Subroutine, Flow Chart (Part 5 of 13)

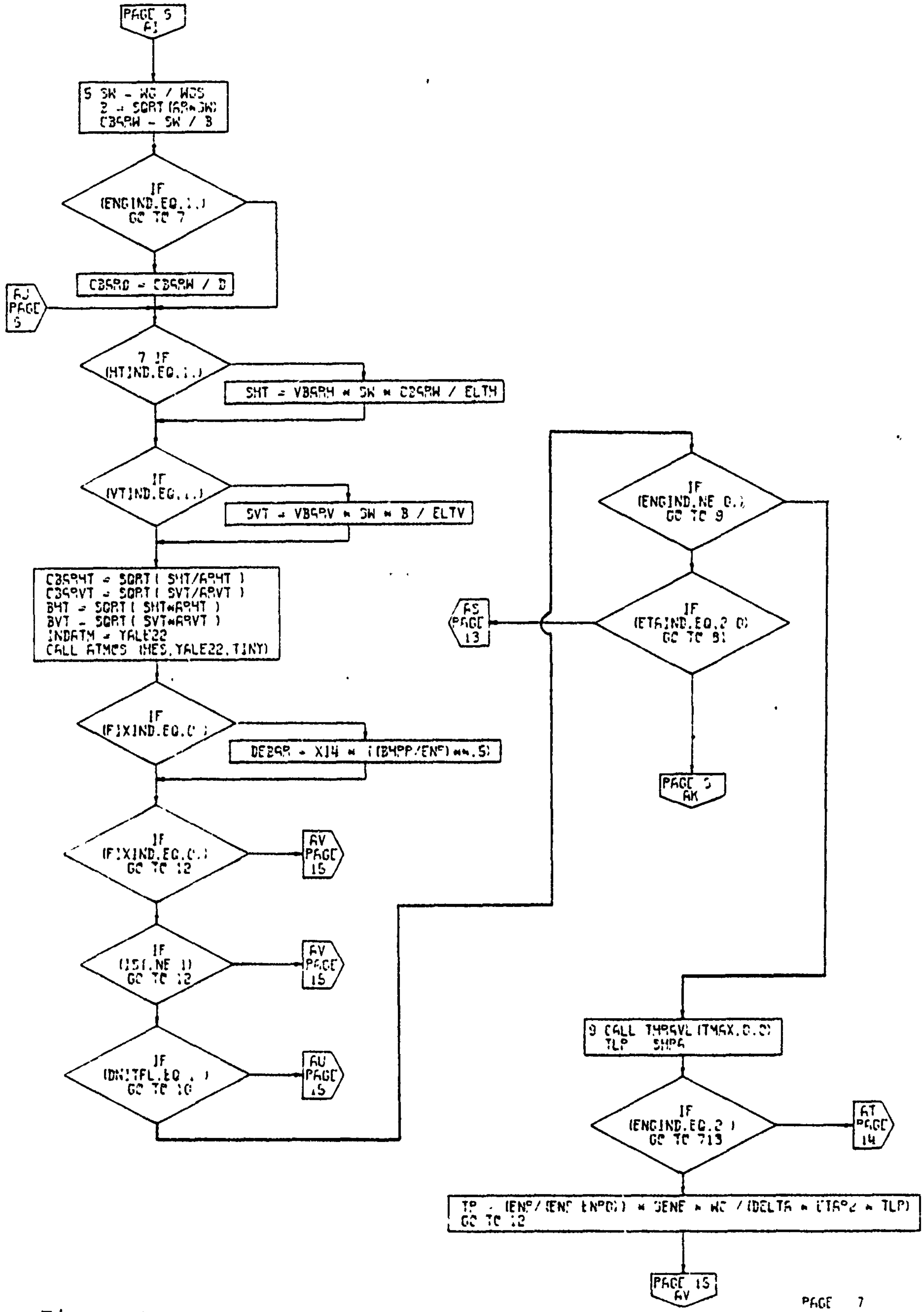
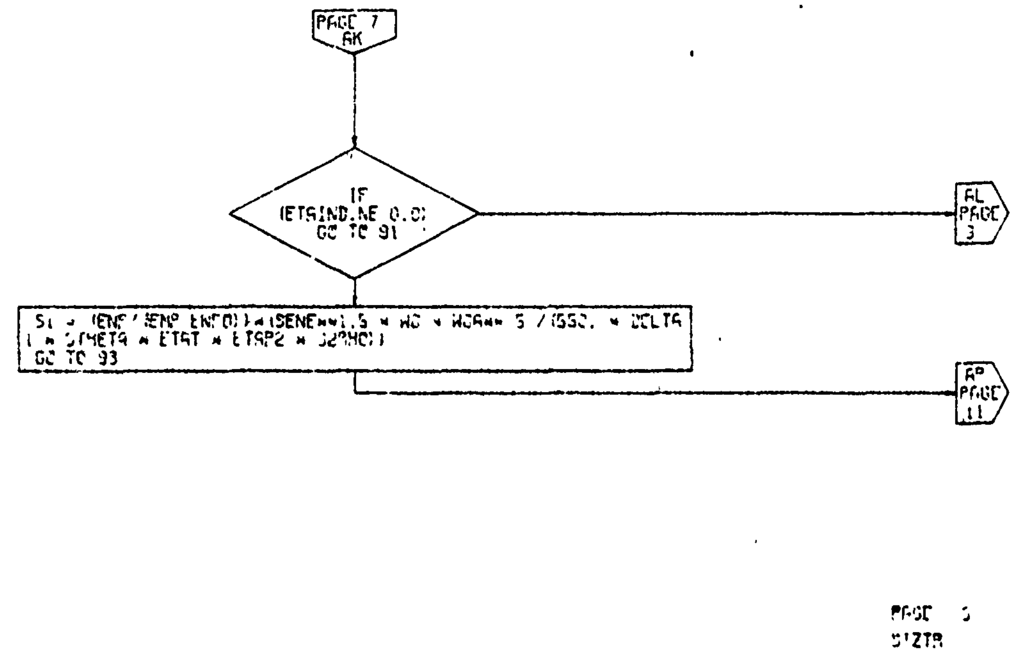


Figure 4-22. Size Trends Subroutine, Flow Chart (Part 6 of 13)



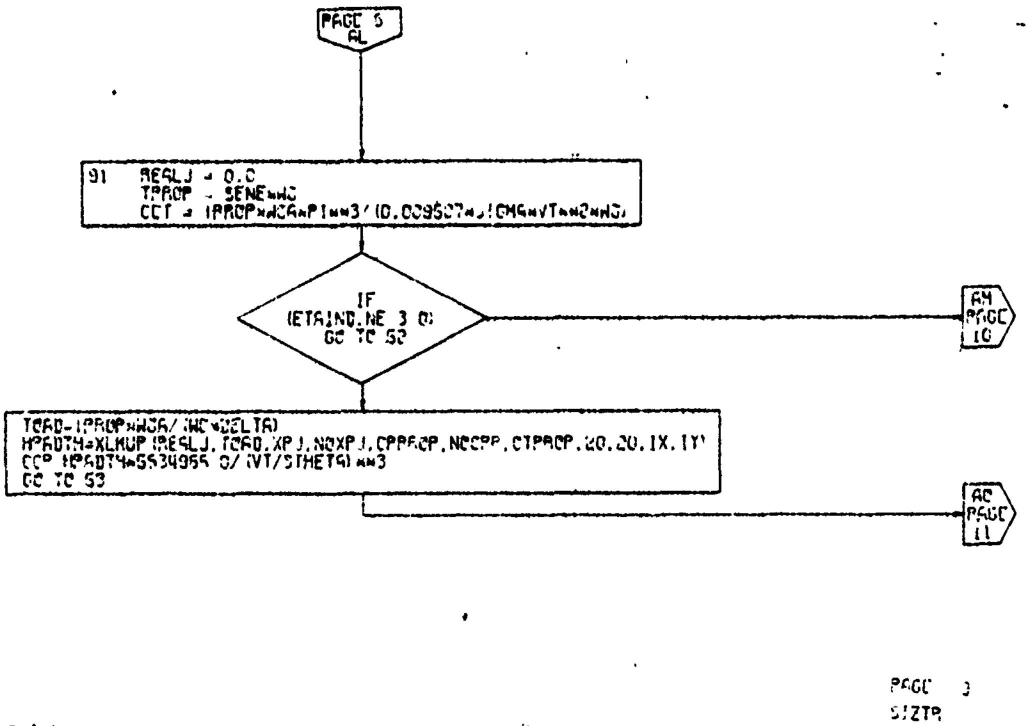


Figure 4-22. Size Trends Subroutine, Flow Chart
(Part 7 of 13)

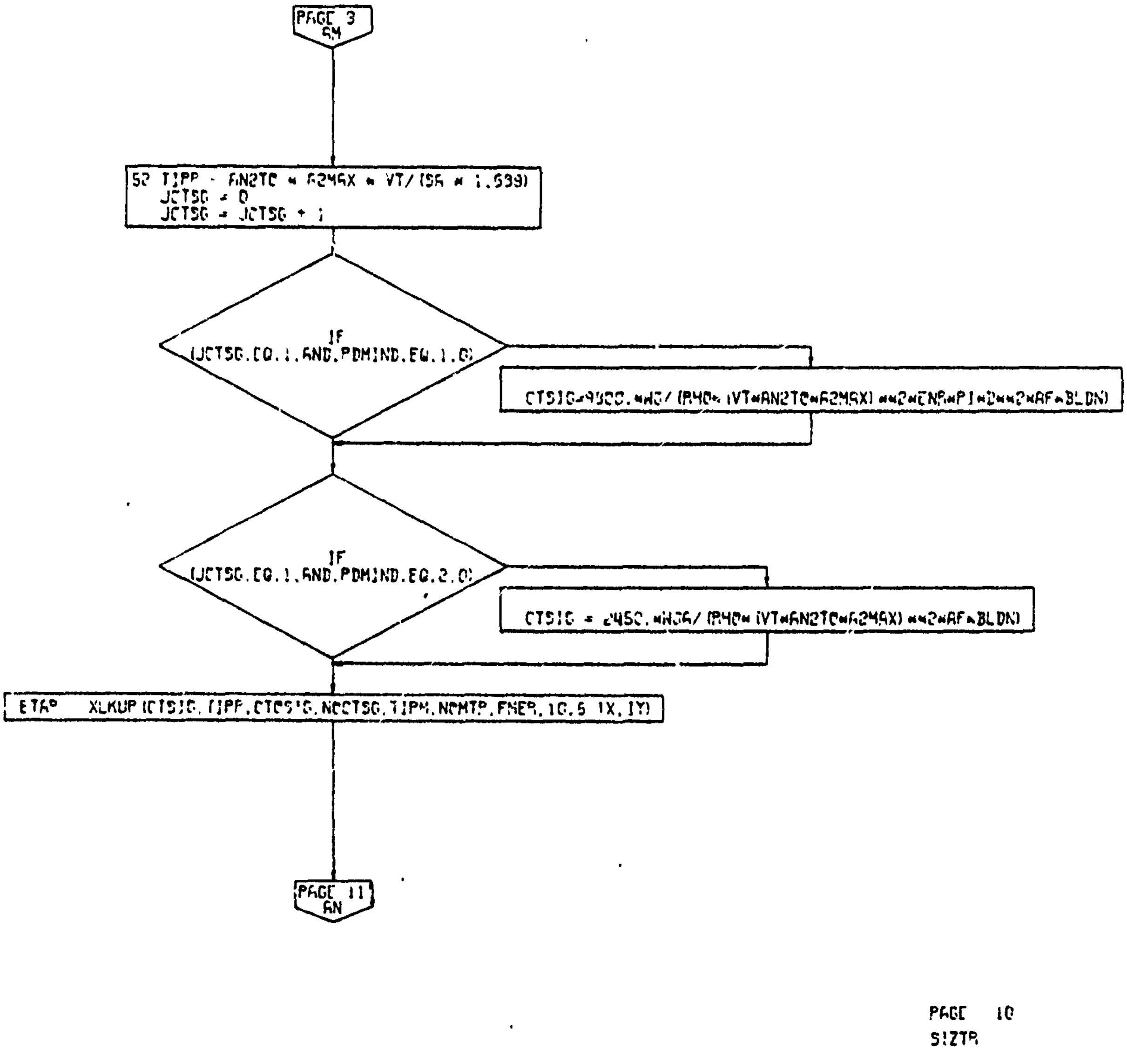


Figure 4-22. Size Trends Subroutine, Flow Chart (Part 8 of 13)

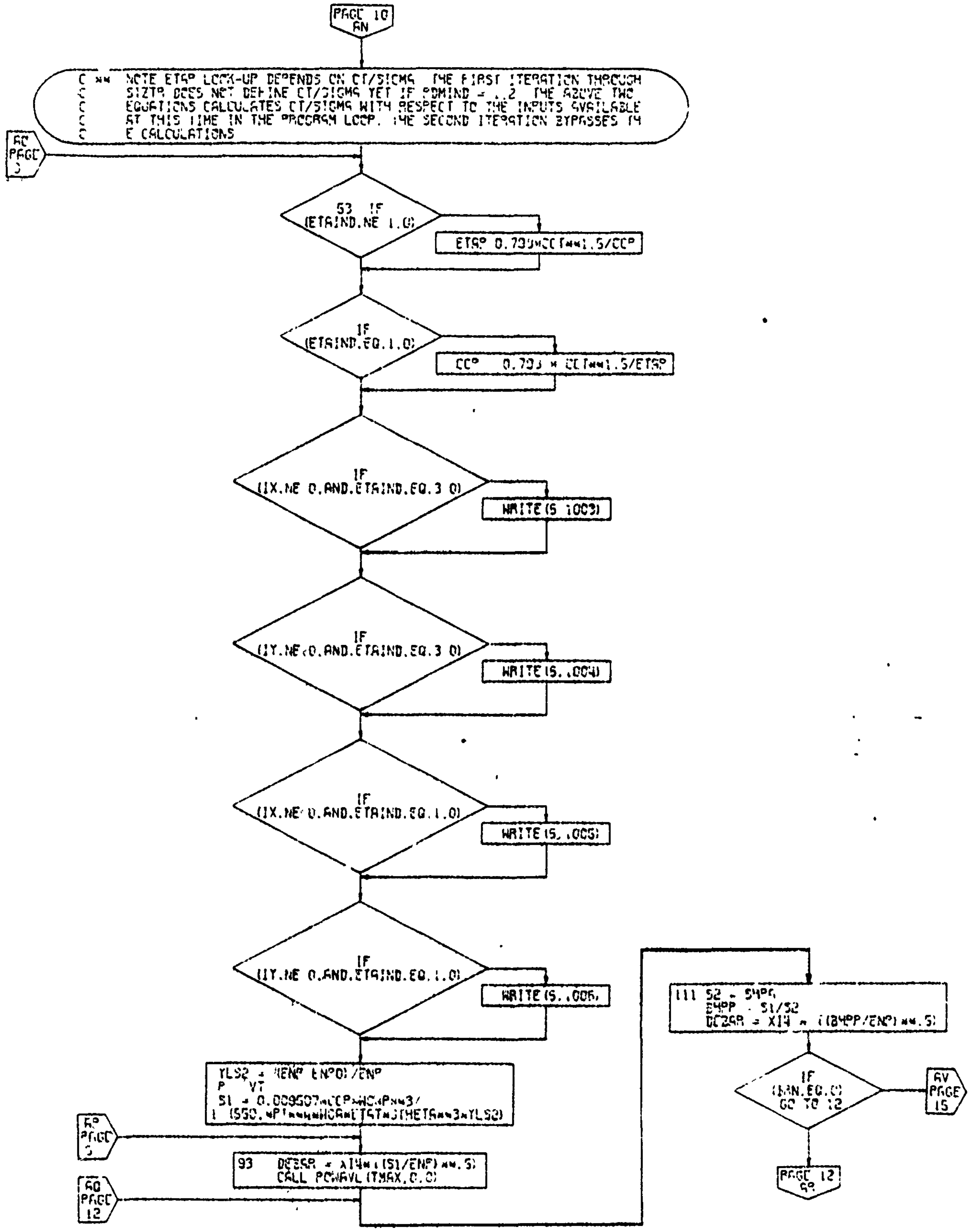


Figure 4-22. Size Trends Subroutine, Flow Chart (Part 9 of 13)

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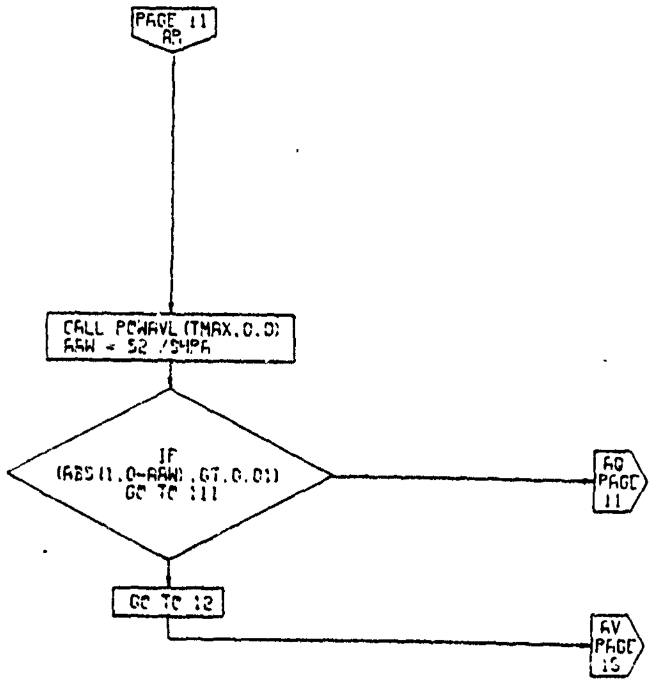

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Figure 4-22. Size Trends Subroutine, Flow Chart (Part 10 of 13)

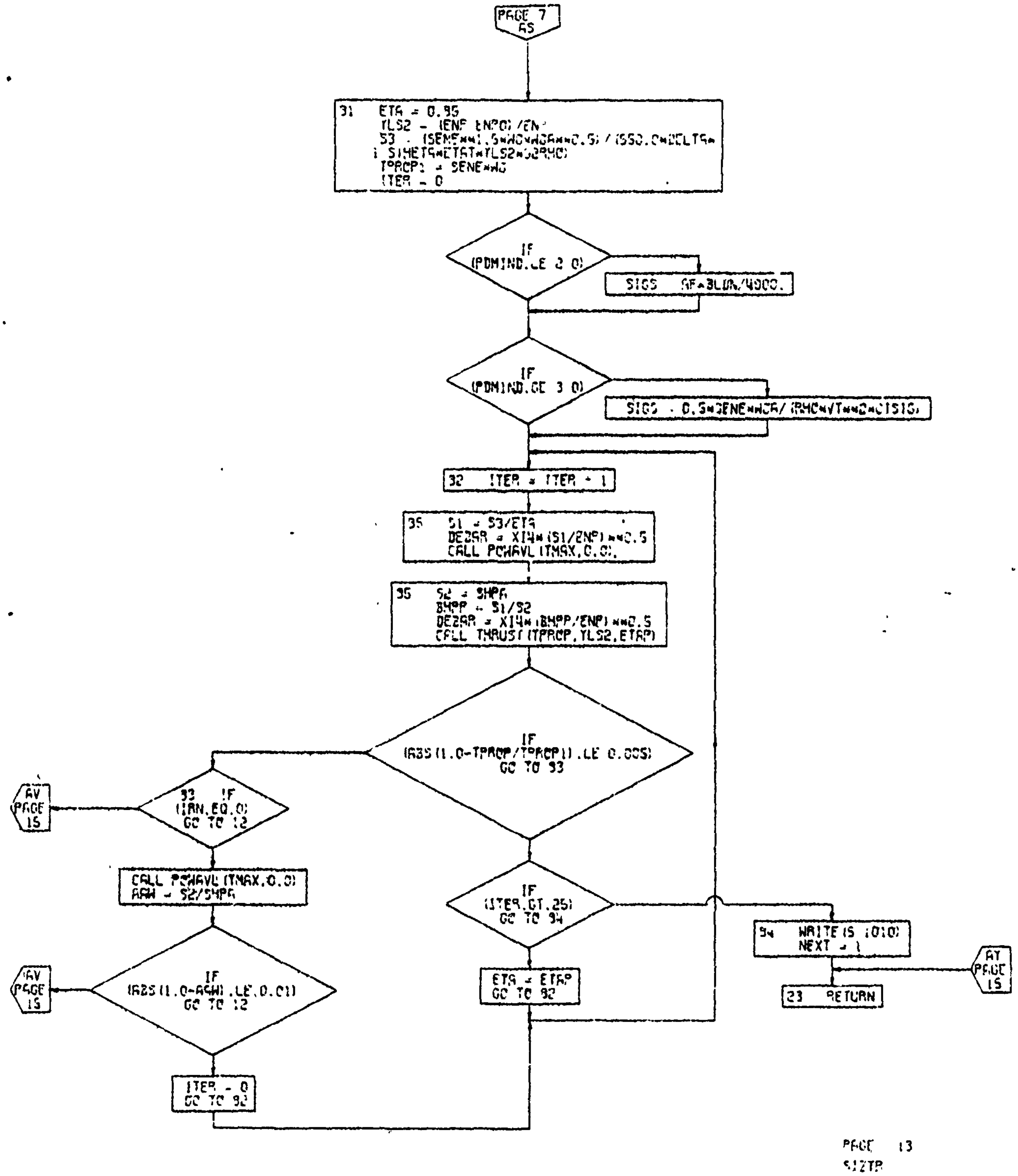
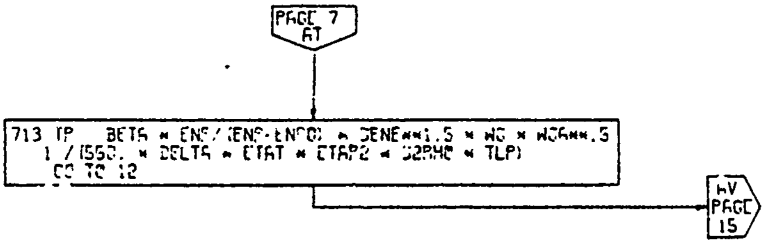


Figure 4-22. Size Trends Subroutine, Flow Chart (Part 11 of 13)



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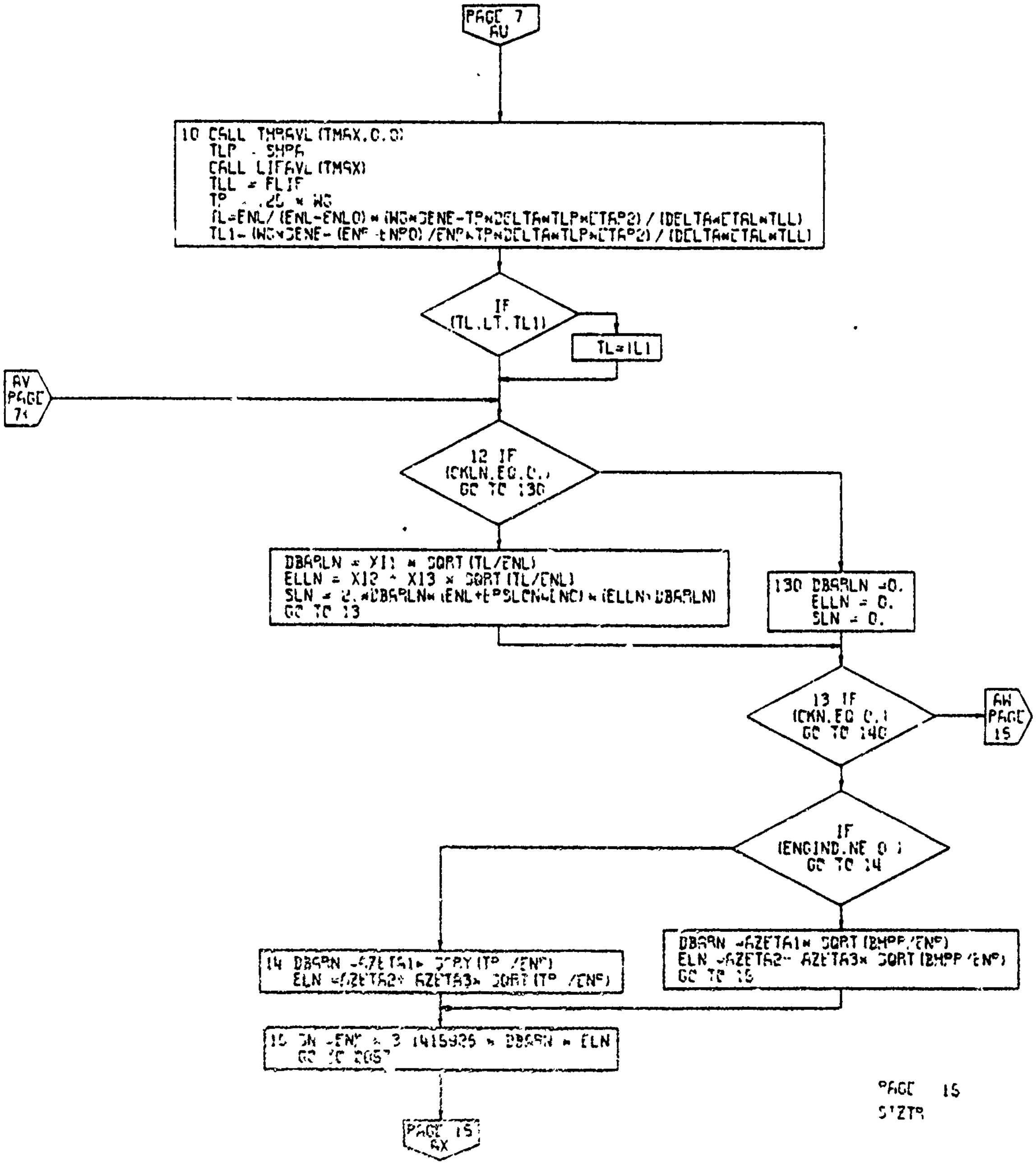

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Figure 4-22. Size Trends Subroutine, Flow Chart
(Part 12 of 13)

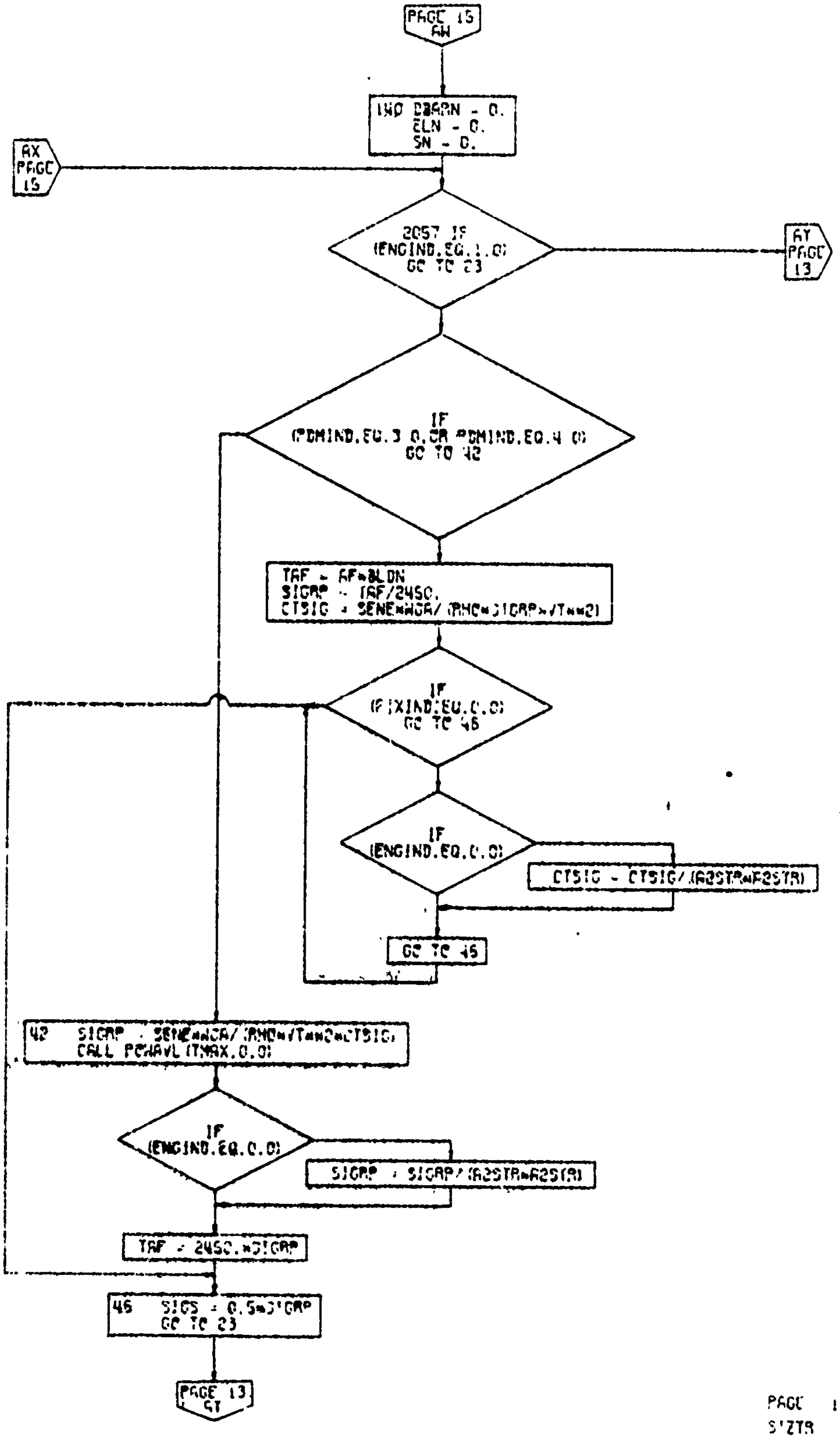


Figure 4-22. Size Trends Subroutine, Flow Chart (Part 13 of 13)

Galleys

The floor area required for galleys is 0.27 square feet per tourist passenger and 0.65 square feet per first class passenger.

The body is assumed to be circular in cross-section. The cabin diameter (I.D.) is determined by the number of seats abreast, unit seat width, number of aisles, aisle width, plus a requirement that adequate clearance be maintained between the window seat passenger and the inside cabin wall. The clearance requirements define a set of sidewall control points, shown in Figure 4-23 . By using these control points, an empirical equation for the cabin radius has been developed (shown in Figure 4-24). The body radius (O.D.) is calculated from (cabin radius) ÷ 0.94. A comparison between predicted and actual body radius for six different commercial aircraft is shown in Figure 4-25.

The body length is made up of a nose section, a constant diameter section, and a tail section. The user specifies the fineness ratio of the nose and tail. Typical values for fineness ratios for commercial aircraft are $(\ell/d)_{NOSE} = 1.5 \rightarrow 2.0$ and $(\ell/d)_{TAIL} = 2.5 \rightarrow 3.5$. The closet floor plan area is calculated by the the program from a trend equation and contributes to the determination of fuselage length. The closet area is 15 square inches per first class passenger and 10 square inches per tourist passenger. The body length is determined by setting the floor plan area required for passengers and services (galleys, lavatories and closets) equal to the area available in nose, tail, and constant diameter sections. The assumption has been made that 1/5th of the nose and tail can be used for passengers and services. A comparison between predicted and actual fuselage length for six different commercial aircraft is shown in Figure 4-26 .

An option is available for calculation of wing dimensions. By use of this option the wing dimensions may be dictated by either wing loading or by propeller geometry as in the case of a tilt-wing aircraft. This option is specified to the program by the user through use of a wing dimension indicator, WDMIND. If WDMIND = 1 or 2, the wing geometry is dictated by propeller characteristics. The user inputs a disc loading, a clearance from inboard propeller tip to inboard propeller tip, propeller to propeller overlap, and wing tip position relative to the outboard propeller. If ENGIND = 1.0 (turbofan engine), do not set WDMIND.

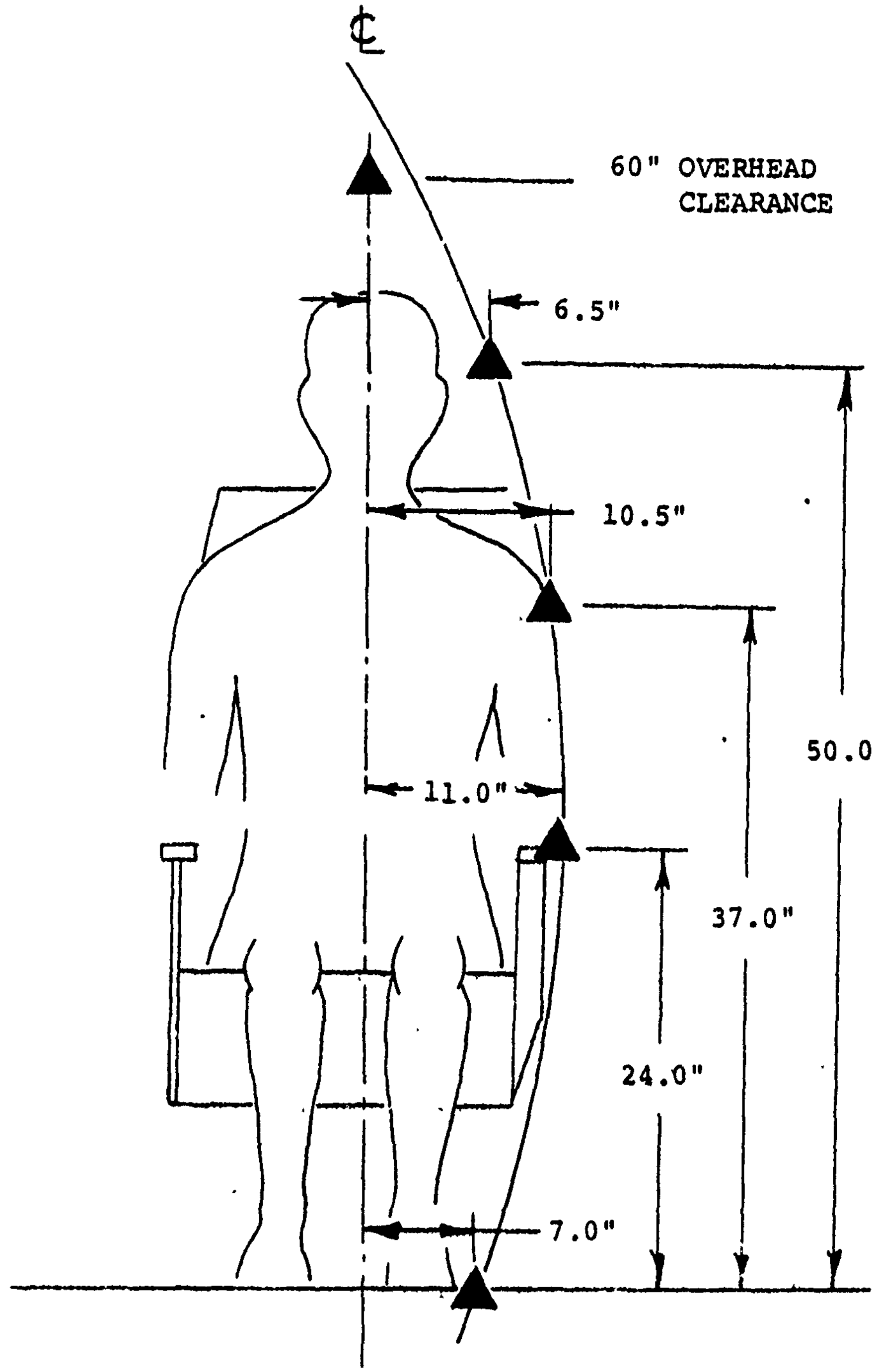


Figure 4-23. Definition of Sidewall Control Points for Fuselage Sizing.

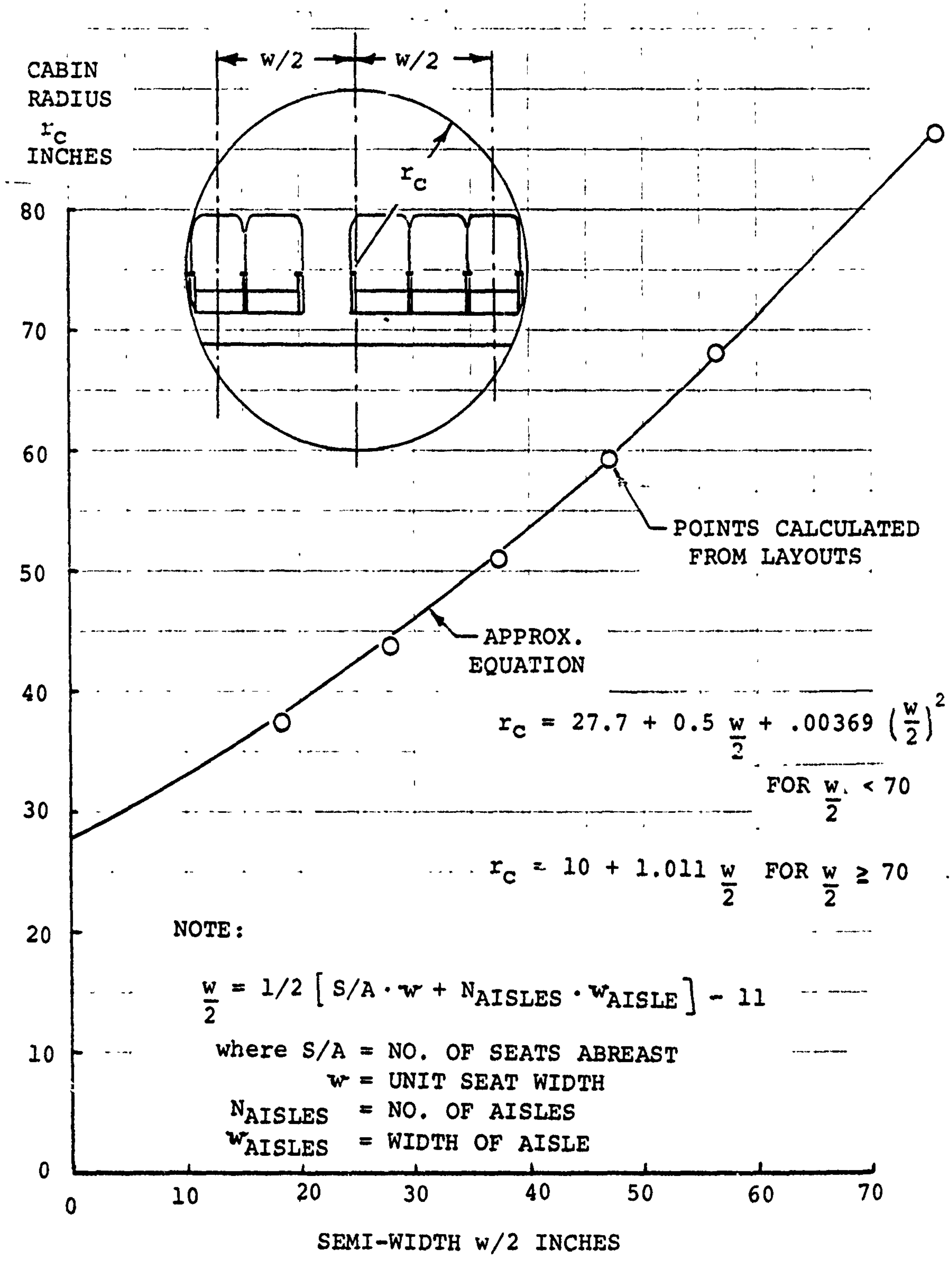


Figure 4-24. Empirical Relationship for Cabin Radius.

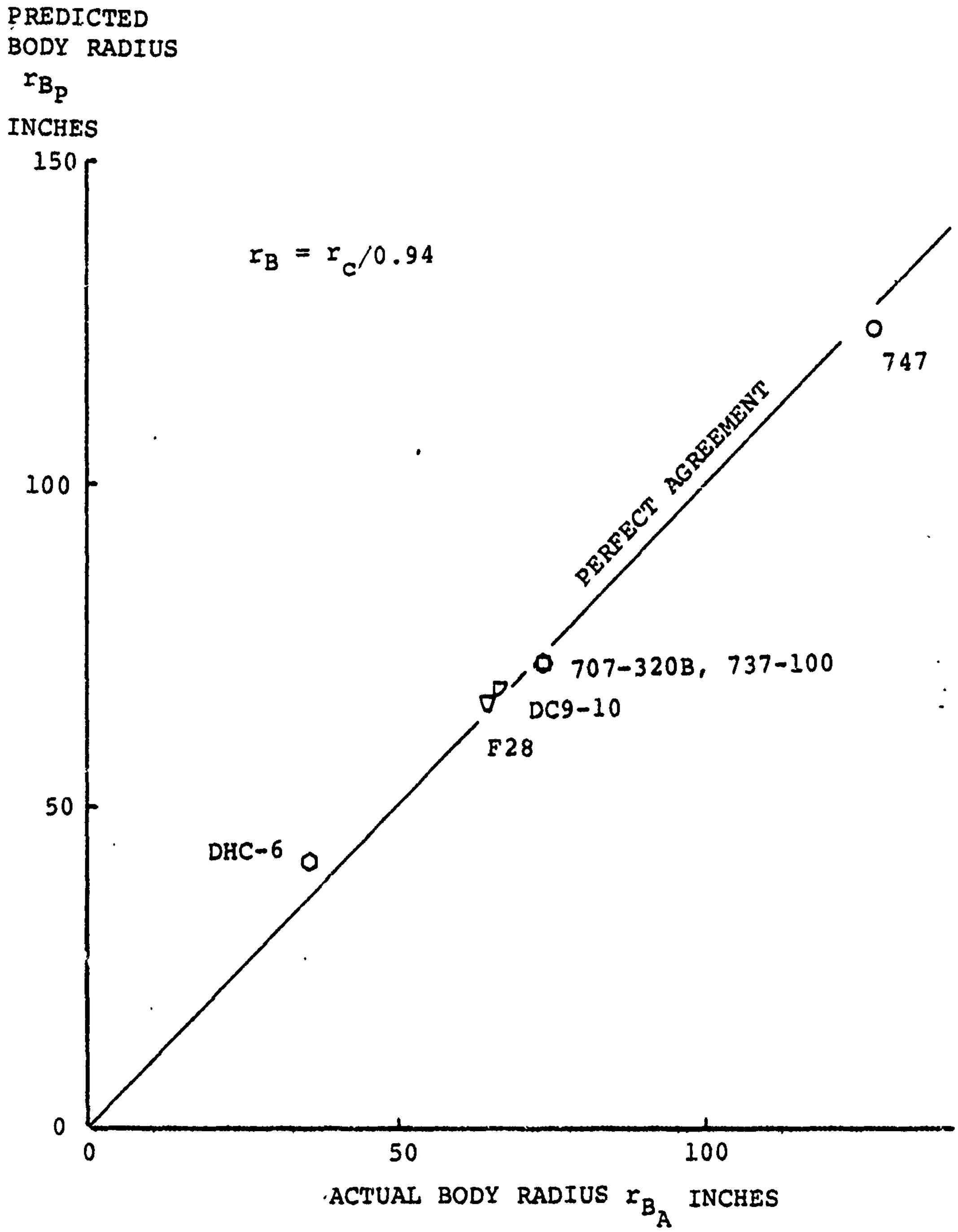


Figure 4-25. Comparison of Predicted Body Radius with Actual Body Radius for Six Commercial Aircraft.

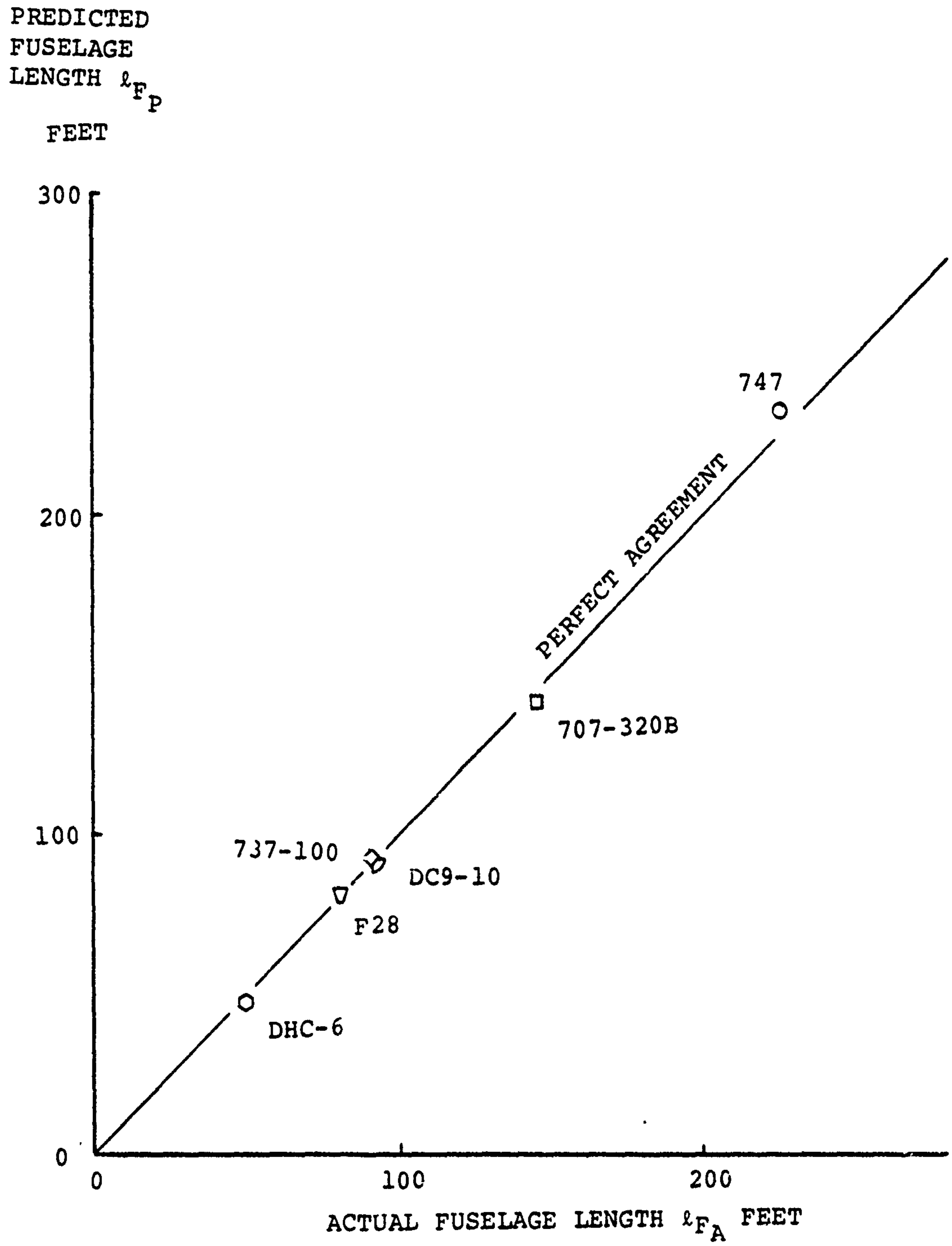


Figure 4-26. Comparison of Predicted Fuselage Length With Actual Fuselage Length for Six Commercial Aircraft.

If WDMIND = 1, the user also inputs a mean chord to diameter ratio and the program calculates wing loading. If WDMIND = 2, the user inputs wing loading and the program calculates mean chord to diameter ratio. In either case the program calculates the mean chord of the wing, the wing span, the wing area, and the aspect ratio. If WDMIND = 0, the wing geometry is dictated by wing loading. The user inputs a wing loading and aspect ratio of the wing. The program then calculates the wing area, span and mean chord. In addition, if turboshaft or convertible engines (ENGIND = 0, or 2) are used, the program calculates a mean chord-to-diameter ratio.

The important propeller dimensions are the diameter and the blade chord (or activity factor or solidity). The diameter may either be input directly or calculated from an input value for the disc loading. The chord may be specified by an input for the activity factor per blade or calculated from an input thrust coefficient-to-solidity ratio. The following choices are available, specified by an input prop dimension indicator, PDMIND:

PDMIND	Input
1	Diameter and activity factor
2	Disc loading and activity factor
3	Diameter and C_T/σ
4	Disc loading and C_T/σ

These options can only be used if the option indicator, OPTIND = 1. If the option indicator is 2 or 3 and it is desired to calculate the propeller performance by the automatic subroutine option (η_PIND=2), the user must input the disc loading and activity factor per blade.

The dimensions of the tail surfaces are next calculated. The areas of the horizontal and/or vertical surfaces may be input as fixed constants by setting the indicator HTIND and/or VTIND to 2.0. Otherwise, by inputting the indicator(s) as unity the program will calculate the tail area(s) from input tail volume coefficient(s). The aspect ratio of each tail surface is also input. The program then calculates the span and mean geometric chord of each tail surface.

The dimensions of the lift nacelle and primary nacelle are next calculated. These dimensions are dictated by the thrust or horsepower level of the engines. The size of the lift engine nacelle is assumed to be primarily dependent upon the physical size of the dry lift engines, the number of clusters of engines, and the gap between engines in a cluster (see Figure 2-1). The size of the

primary engine nacelles is more often dictated by the design of the transmission system and less often by the physical size of the dry engines. Separate input constants z_1, z_2, and z_3 are used to calculate the size of the primary engine nacelles:

$$\text{diameter (ft)} = z_1\left[\frac{SHP^*}{N_P}\right]^{1/2} \text{ or } z_1\left[\frac{F_N^*}{N_P}\right]^{1/2}$$

$$\text{length (ft)} = z_2 + z_3\left[\frac{SHP^*}{N_P}\right]^{1/2} \text{ or } z_2 + z_3\left[\frac{F_N^*}{N_P}\right]^{1/2}$$

$$\text{wetted area (ft}^2) = N_P\pi(\text{dia.})(\text{length})$$

Correlation of data for nacelle size, within fixed categories of aircraft, show that this representation gives reasonable accuracy.

4.7 AERODYNAMICS CALCULATIONS SUBROUTINE

The aerodynamics subroutine calculates the lift curve slope and a series of factors which are used for calculation of drag. The drag calculation has been written in the most general manner possible. The drag is assumed to be divided into profile drag, induced drag, and compressibility (wave) drag. The profile drag is further divided into a portion for each component of the aircraft. The wing profile drag is assumed to be a function of lift coefficient, as specified by an input table. The other portions of profile drag are single-value points. The profile drag is input at a reference Reynolds' number of 10^7, and the program calculates a variation with Reynolds' number. Form factors for each component are input to the program. These factors can also be used to represent interference or for sensitivity studies. The fuselage drag is calculated as the sum of two terms: one proportional to wetted area and one which is constant. Therefore, if a known fuselage is being studied, the constant value can be input and the other term set to zero. Otherwise, the opposite can be done.

The drag is assumed to be equal to:

$$C_D = \underbrace{C_{DWi}\,[f_W(Re)]}_{\text{Wing Profile}} + \underbrace{\left(\frac{.00287\,K_F\,S_F + \Delta f_e}{S_W}\right)[f_F(Re)]}_{\text{Fuselage Profile}}$$

$$+ \underbrace{K_{VT}\,\frac{S_{VT}}{S_W}\,C_{DVTi}\,[f_{VT}(Re)]}_{\text{Vert. Tail Profile}} + \underbrace{K_{HT}\,\frac{S_{HT}}{S_W}\,C_{DHTi}\,[f_{HT}(Re)]}_{\text{Hor. Tail Profile}}$$

$$+ - - - - \underbrace{+\,\Delta C_D}_{\text{Arbitrary}} + \underbrace{K_W\,\Delta C_{DM}}_{\text{Compressibility}} + \underbrace{C_L^{\,2}/\pi e\,AR}_{\text{Induced}}$$

The compressibility drag (ΔC_{DM}) is calculated according to a semi-empirical technique. The terms of the drag equation are combined in the following form:

$$C_D = a_5 + a_6\,C_{DWi} + K_W\,\Delta C_{DM} + a_7\,C_L^{\,2}$$

where

$$a_5 = \left(\frac{.00287\ K_F\ S_F + \Delta f_e}{S_W}\right)[f_F(Re)]$$

$$+ K_{VT}\ \frac{S_{VT}}{S_W}\ C_{DVTi}\ [f_{VT}\ (Re)] + - - + - - - + \Delta C_D$$

$$a_6 = K_W\ [f_W\ (Re)]$$

$$a_7 = 1/\pi e\ AR$$

The factors a_5 through a_7 (and a_1 through a_4, for compressibility drag) are used in the drag calculations subroutine to calculate C_D as a function of C_L and M.

The terms $f_W(Re)$, f_F (Re), f_{VT} (Re), etc., are Reynolds' number functions for the wing, fuselage, vertical tail, etc., which reflect the variation of skin friction coefficient with Reynolds' number. The function which is used is a normalized form of the Prandtl-Schlichting turbulent flat plate skin friction equation:

$$f(Re) = \frac{C_f}{C_{f_{Re=10^7}}} = [1 + \frac{1}{7}\log_{10}\frac{R_e}{10^7}]^{-2.6}$$

The program user inputs a value for average Reynolds number per foot for the mission and the program then calculates the Reynolds' number for each component of the aircraft and uses the Reynolds' number functions f_W (Re), f_F (Re), etc., to determine the variation in component drag as the aircraft dimensions change during the iteration on gross weight. The individual profile drag coefficients, C_{DVTi}, C_{DHTi}, etc., are input at a reference Reynolds' number of 10^7.

The user inputs values for the profile drag coefficients (C_{DVTi}, C_{DWi}, etc.), for the interference factors (K_F, K_W, etc.), for the mean Reynolds' number per foot, (R_e/ℓ), and for the efficiency factor, e (the program will calculate e if OSWIND is input as unity). The program then calculates the values for a_1 through a_7 for use in the drag calculations subroutine. The user also inputs the two dimensional lift curve slope, and the program calculates the three dimensional value for lift curve slope.

The drag routine may be used in many different ways. The four most common applications are:

1. Drag Build-up for a New Aircraft Design - This is best illustrated by first referring to the complete drag breakdown of a hypothetical airplane shown in Table 4-4. The input C_D for each component (C_{DWi}, C_{DHTi}, etc.) may be used to represent the reference C_f at $R_e = 10^7$ and at the mean flight Mach number. Drag increases above the drag of a flat plate such as three dimensional effects, interference, roughness, and excrescences may be accounted for by the multiplying factors (K_W, K_{HT}, etc.). Drag increments which are not proportional to skin friction can be summed and input as ΔC_D. Examples of these increments are cooling momentum, trim, and airconditioning. The K factor for wings and tails should include a factor for relating the wetted area of the surface to the planform area. An example of the program input for the hypothetical airplane of Table 4-5 is shown in Table 4-6.

2. Study of the Sensitivity of Aircraft Size with Respect to the Component Drag or the Total Drag about a Certain Drag Level - Let the total drag of each component be contained in the drag coefficient of each component, C_{DWi}, C_{DHTi}, C_{DVTi}, etc. The change in drag of each component will then be determined by the values assigned to the component multiplying factor, K_W, K_{HT}, K_{VT}, etc. The fuselage drag change, however, will have to be represented by an incremental value of Δf_e.

3. Use of Component Drag Data from Wind Tunnel Test - Let the drag of each component (including interference) be contained in the component drag coefficient, C_{DWi}, C_{DHTi}, C_{DVTi}, etc. The skin friction drag must first be corrected to $R_e = 10^7$. The drag increase due to items found only on the full scale airplane would then be represented by the factors and increments. Increases due to excrescences and roughness are represented by the factors, K_W, K_{HT}, K_{VT}, etc. Increments such as inlets, cooling, trim, and afterbody drag, can be summed and represented by ΔC_D.

4. Simplified Drag Model for Parametric Studies - The program is often used to study the influence of variations of parameters such as wing loading and disc loading on the size of an aircraft. During these studies, the type of aircraft (such as four propeller tilt wing) is generally held constant. For studies of this type it may be possible to represent the total flat plate area

TABLE 4-5
TYPICAL DRAG SUMMARY

DRAG BREAKDOWN FOR HYPOTHETICAL 4 PROP TILT-WING AIRCRAFT $R_e/ft = 3.0 \times 10^6$, $M = .40$					
COMPONENT	Wetted Area	C_f	INCREMENT %	INCREMENT Δf_e	f_e FT^2
FUSELAGE	2027.	.00185		3.75	7.08
3-Dimensional Effects			20.0	.75	
Excrescences			7.0	.31	
Canopy			5.0	.22	
Afterbody				2.05	
WING	1290.	.00246		3.17	5.25
3-D Effects			33.0	1.05	
Excrescences			4.0	.17	
Flaps, Slats, Ailerons, Spoilers			16.0	.63	
Body Interference			7.0	.23	
HORIZONTAL TAIL	477.	.00258		1.23	1.94
3-D Effects			20.6	.41	
Excrescences			8.6	.14	
Interference			10.0	.16	
VERTICAL TAIL	398.	.00235		.94	1.49
3-D Effects			33.0	.31	
Excrescences			8.6	.11	
Interference			10.0	.13	
INBOARD NACELLES	286.	.00228		.65	1.72
3-D Effects			35.0	.23	
Excrescences			20.0	.16	
Interference			88.0	.63	
Inlets				.05	
OUTBOARD NACELLES	331.	.00228		.76	1.70
3-D Effects			35.0	.27	
Excrescences			20.0	.21	
Interferences			40.0	.41	
Inlets				.05	
LANDING GEAR POD	338.	.00218		.74	1.46
3-D Effects			45.0	.34	
Excrescences			10.0	.11	
Interference			25.0	.27	
MISC. Roughness (5.0% of $C_f A_{WET}$)				.56	1.56
MISC. Cooling				.50	
MISC. Trim				.30	
MISC. Air Conditioning				.20	
TOTALS ft^2	5147.				22.20

Notes: (1) Basic $f_e = (C_f A_{WET}) + (\text{3-D Effects } \Delta f_e)$

(2) Excrescences & interference are % of basic f_e

TABLE 4-6
SUMMARY OF AERODYNAMICS INPUT
FOR AIRCRAFT OF TABLE 4-3

GENERAL	
	$C_{DWi} = C_{DVTi} = C_{DHTi} = C_{D_N} = C_f = .00287$ @ $R_e = 10^7$, $M = 0.40$ $(R_e/\ell)_i = 3.0 \times 10^6$
COMPONENTS	$S_F = 2027$ fuselage wetted area
FUSELAGE	$K_F = (1 + \underbrace{.20}_{\text{3-D effects}})(1 + \underbrace{.07}_{\text{excr.}} + \underbrace{.05}_{\text{canopy}}) + \underbrace{.05}_{\text{roughness}} = 1.394$ $\Delta f_e = \underbrace{\left(\frac{.00287}{.00185}\right)}_{\text{body } C_f}(\underbrace{2.05}_{\text{aft body}} + \underbrace{.10}_{\text{nacelle inlets}} + \underbrace{.50}_{\text{cooling}} + \underbrace{.20}_{\text{air conditioning}}) = 4.417$
WING	$K_W = \underbrace{(1.75)}_{\left(\frac{A_{WET}}{S_W}\right)}[(1 + \underbrace{.33}_{\text{3-D effects}})(1 + \underbrace{.04}_{\text{excr.}} + \underbrace{.16}_{\text{flaps, slats ail., spoilers}} + \underbrace{.07}_{\text{interf.}}) + \underbrace{.05}_{\text{roughness}}] = 3.043$
TAIL	$K_{HT} = 2.034\ [(1 + .206)(1 + .086 + .10) + .05] = 3.011$ $K_{VT} = \underbrace{2.057}_{\left(\frac{A_{WET}}{S_{VT}}\right)}[(1 + \underbrace{.33}_{\text{3-D effects}})(1 + \underbrace{.086}_{\text{excr.}} + \underbrace{.10}_{\text{interf.}}) + \underbrace{.05}_{\text{roughness}}] = 3.347$
NACELLES	$K_N = (1 + .35)\left[1 + .20 + \frac{(.88 + .40)}{2}\right] + .05 = 2.534$
MISC	$\Delta C_D = .00040$ for trim Cooling, air conditioning and nacelle inlets are included in the fuselage Δf_e

of the family of aircraft as a linear function of the wing area. This representation of drag can be input to the program by three values: Δf_e representing the drag at zero wing area, ΔC_D representing the slope of the curve, and $K_W = 1$.

The three dimensional lift curve slope which is calculated is based upon the method of Reference 3, which accounts for aspect ratio, wing sweep, and Mach number effects. For the purpose of this program, the Mach number effects are not included. Rather, the value of lift curve slope is evaluated at a Mach number = $.87M_{MO}$, which gives a reasonably accurate value for use during climb and descent calculations.

Figure 4-27. is a flow chart of this subroutine.

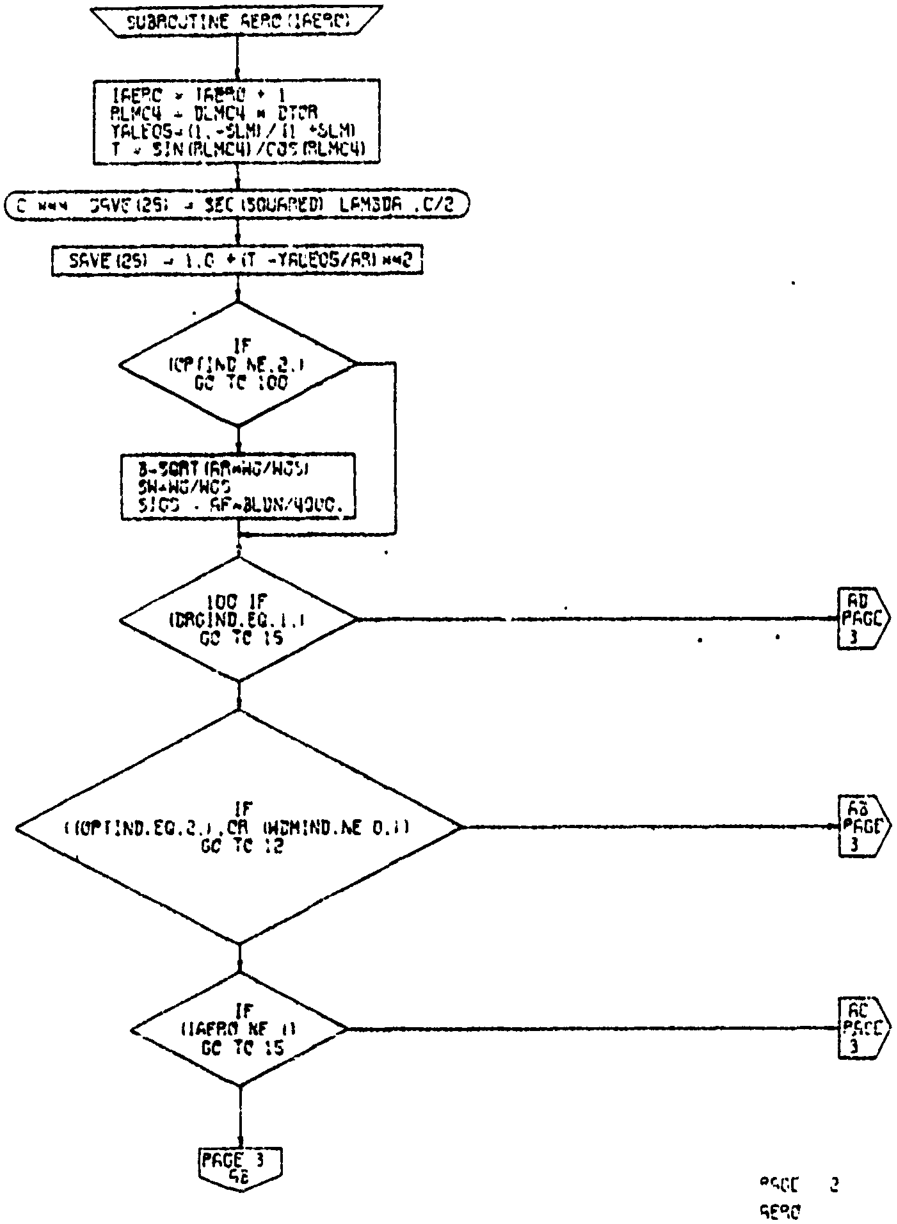


Figure 4-27. Aerodynamics Subroutine, Flow Chart
(Part 1 of 4)

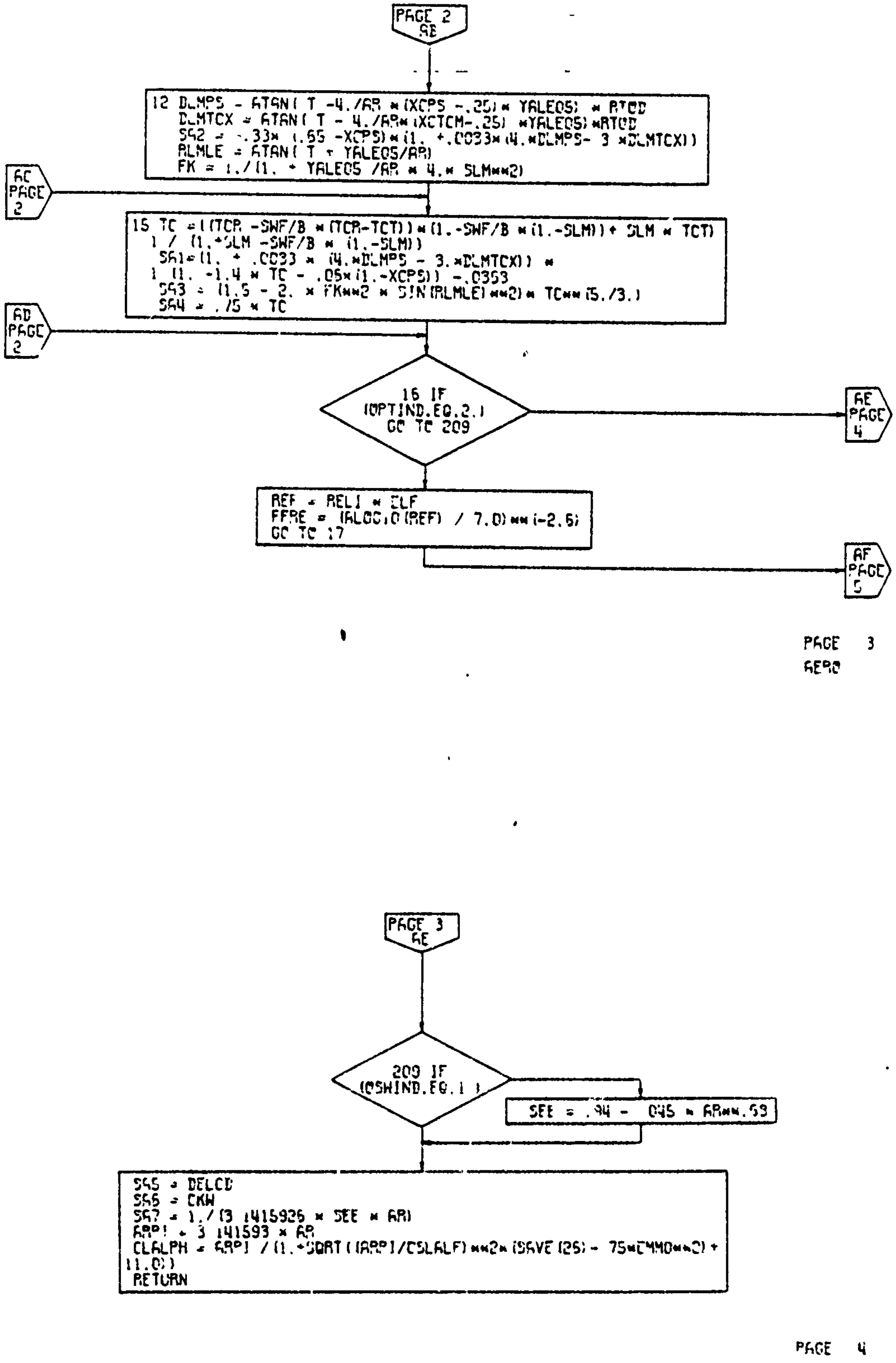


Figure 4-27. Aerodynamics Subroutine, Flow Chart
(Part 2 of 4)

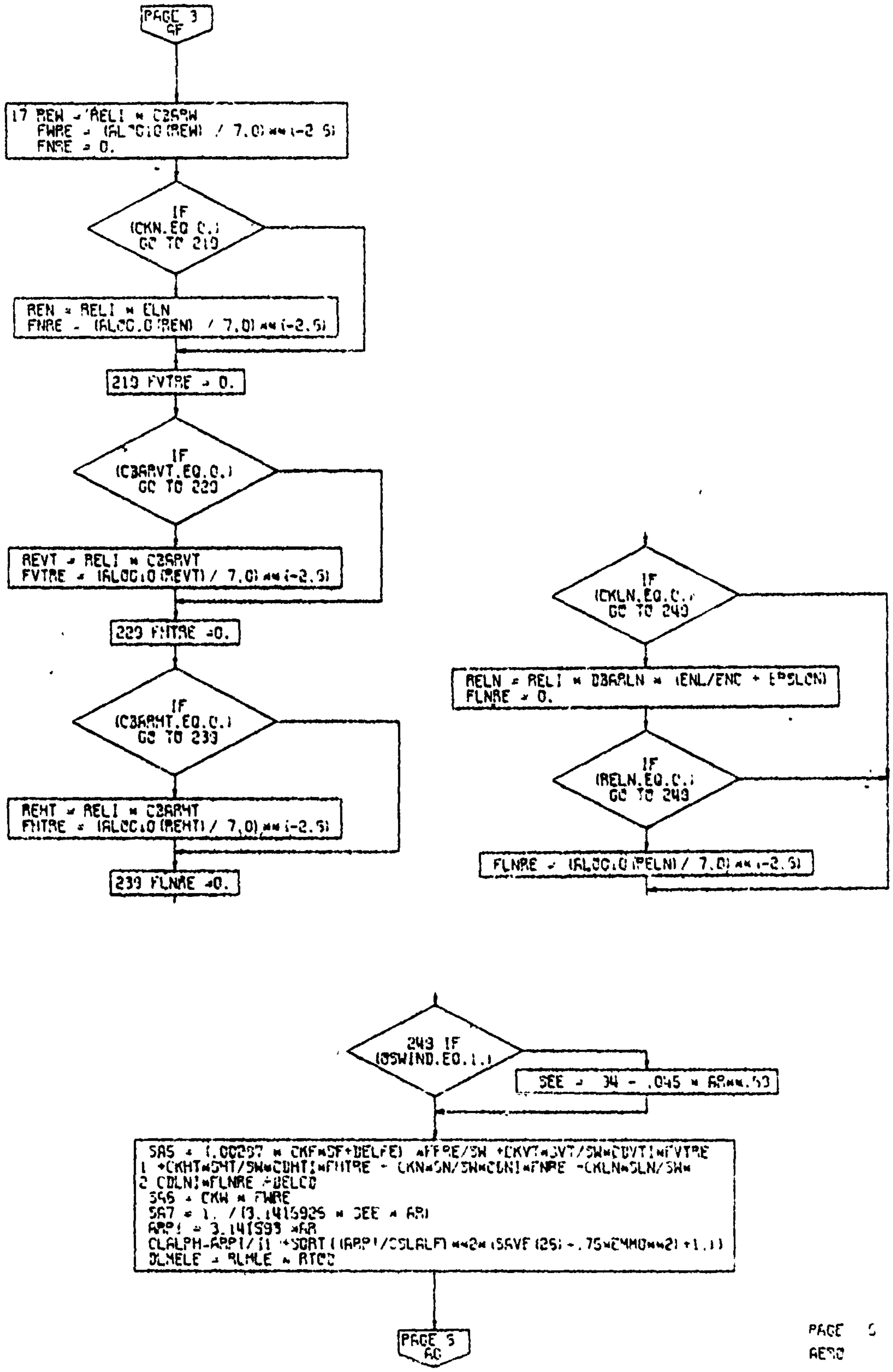


Figure 4-27. Aerodynamics Subroutine, Flow Chart
(Part 3 of 4)

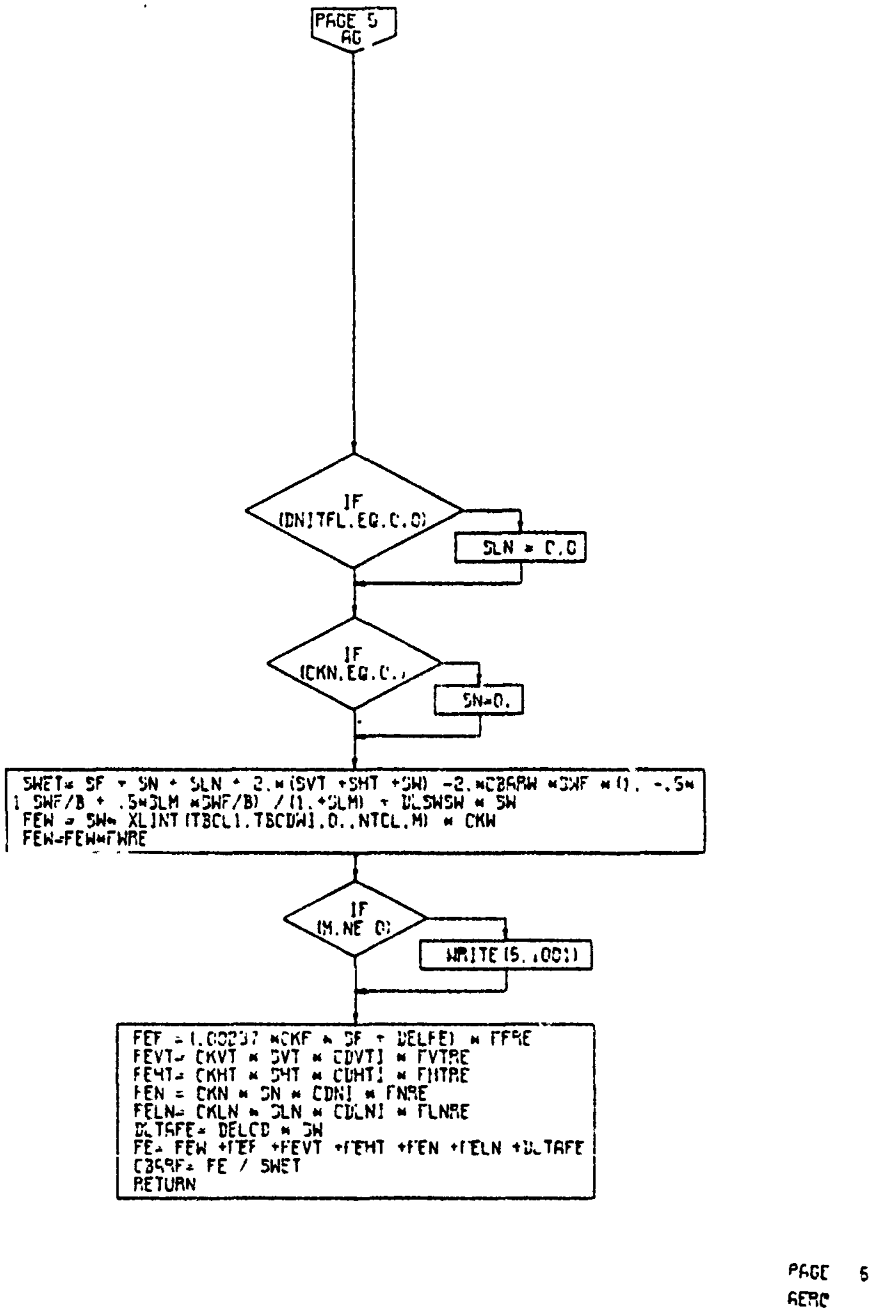


Figure 4-27. Aerodynamics Subroutine, Flow Chart
(Part 4 of 4)

4.8 ENGINE SIZING SUBROUTINE

The engine cycle performance data included in the engine library consists of detailed performance maps of power (or thrust), fuel flow, N_I, and N_{II}. The data, as shown in Table 4-1, is in normalized, referred format. In particular, horsepower is normalized with respect to the value of power at the maximum static rating at sea level, standard day conditions. Thrust is similarly normalized to the maximum static thrust at sea level, standard day.

The engine sizing subroutine calculates the value of the scaling factors; namely, the maximum static thrust or power (S.L., std.). The user is permitted to bypass this subroutine completely if he desires to study an aircraft with fixed rather than "rubberized" engines. This is accomplished by means of the input indicator FIXIND. If FIXIND = 0, the engine sizing subroutine is bypassed, and the user inputs the maximum power or thrust levels. If FIXIND is input as 1.0, the engine sizing subroutine is entered to calculate these values of maximum power or thrust.

A variety of different criteria are often applied to determine engine size requirements. These criteria, differing as they do, can generally be related by a single factor. For a takeoff condition this factor is the value of equivalent required thrust to weight ratio. Similarly, engine sizing requirements for forward flight can be related to a set of cruise conditions, namely, cruise altitude and true airspeed. Relationships used in this program to size the engines differ depending upon whether or not separate lift propulsion has been selected. Engine sizing requirements for V/STOL aircraft which do not contain separate lift propulsion are generally set by takeoff conditions, and less frequently by forward flight conditions. The program, therefore, permits the user two options of calculation for this type of aircraft. The first option will calculate engine size for takeoff conditions only; the second option will calculate engine size for both takeoff and forward flight conditions, compare the two, and pick the more critical condition. The engines are sized for takeoff to provide a required (input) equivalent thrust to weight ratio with a specified (input) number of engines inoperative.

Additional engine sizing parameters have been added for either the turboshaft (ENGIND = 0.0) or convertible (ENGIND = 2.0) engine. Expanded capabilities include a direct horsepower input to drive accessory options (LOC 0259), primary or lift engine sizing at a specified fraction of power (LOC 0260), and engine sizing for takeoff conditions at a specified vertical rate of climb (LOC 0261).

If separate lift propulsion is used, the cruise engines are first sized to meet specified forward flight conditions. The lift engines are then sized to provide sufficient additional thrust to meet the takeoff requirements. The lift engines are sized to provide this additional thrust with either a specified number of primary engines inoperative or a specified number of lift engines inoperative. The program calculates the thrust required to meet each of these conditions, compares them, and picks the more critical condition. Takeoff or cruise conditions or both may be set for standard or nonstandard atmosphere.

Cruise conditions are specified by means of altitude, ambient temperature, and true airspeed. In addition, the user may select the power setting to be used: maximum, military, or normal.

In addition to performing engine sizing, this subroutine calculates the drive system rating. The two options available to the user for this purpose are:

XMSNIND = 0.0 (LOC 0257)	Transmission is sized at a specified fraction of primary installed engine power
XMSNIND = 1.0	Transmission is sized at a specified fraction of power required to hover or cruise (program picks more critical condition)

It should be noted that when FIXIND (LOC 0010) = 0.0, fixed size engines, either transmission sizing option can be used. The Fortran coding that sizes the transmissions with fixed engines is found in the MAIN subprogram. The transmissions can be sized irregardless of the propeller performance option used (ηPIND LOC 0200). If XMNSD = 1.0 is exercised for fixed size engines, the program will calculate the required powers, and size the transmission even if the required power is greater than the fixed sized input power.

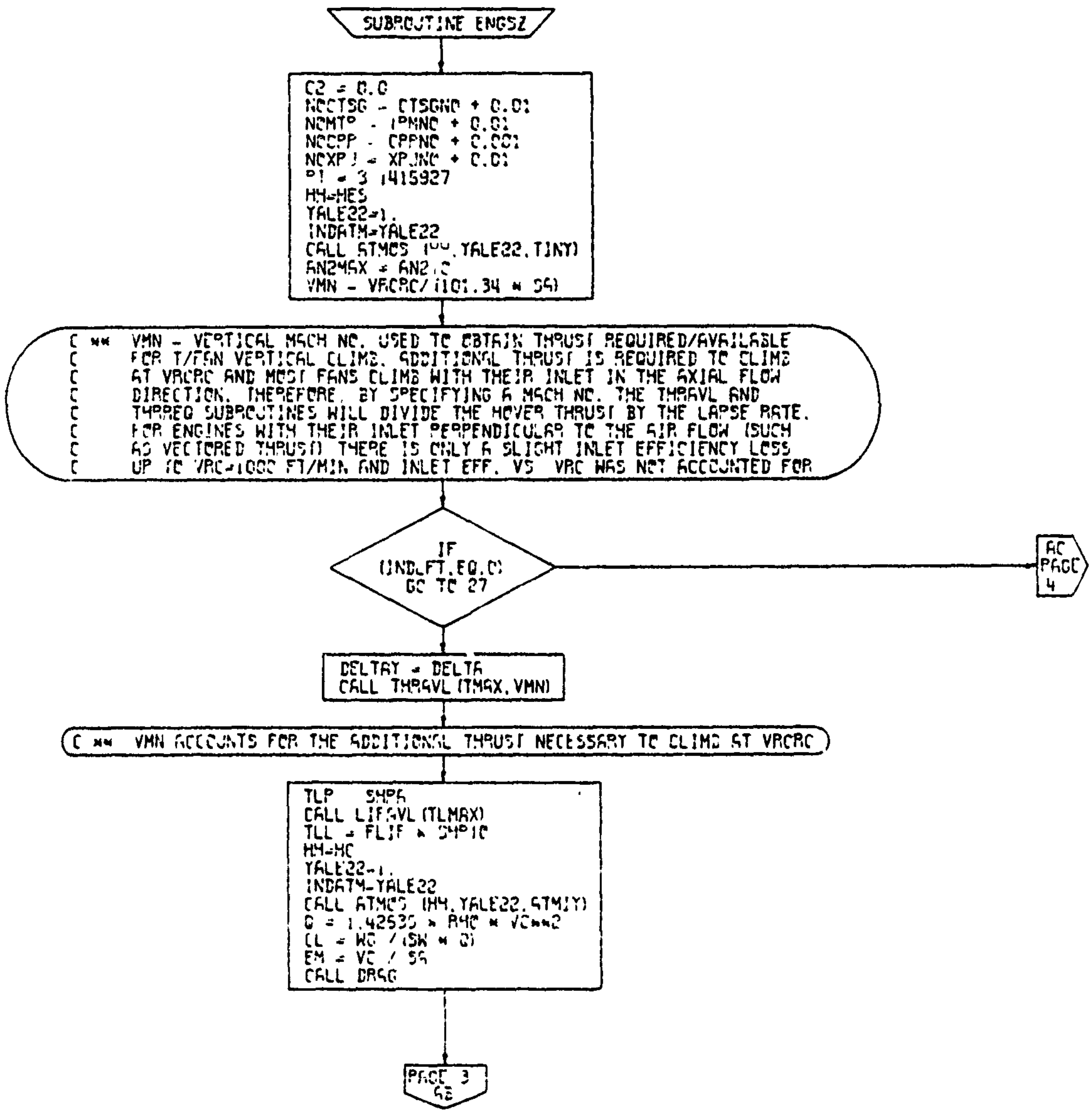
If ENGIND = 0, (LOC 0011), both transmission options are available to the user. For ENGIND = 1, transmission sizing is not possible, thus the program bypasses the transmission sizing inputs. For convertible engines, ENGIND = 2.0, the XMSNIND = 0 option can be used without any constraints. Since convertible engines do not use a transmission for cruise, XMSNIND = 1.0 cannot be used. If ENGIND = 2.0 and XMSNIND = 1.0, the program will automatically apply the transmission limit as a specified fraction of installed takeoff power, and an informative message will be printed out.

The use of separate engines and transmission sizing options provides great flexibility in meeting conflicting engine/drive system requirements. As an example, if XMSNIND = 1.0, it is possible to size an aircraft's engines to meet an engine inoperative in hover requirement while sizing the transmission for the actual power required to hover at that design point, thus effecting a considerable saving in drive system weight. If XMSNIND = 0.0, it is possible to size the engines for cruise at 3000 ft/91.5°F, 250 Kts, but the transmission could be sized at 90% of the cruise power design point.

The transmission designed operating tip speed is passed from the engine sizing subroutine to the weight trend subroutine so that the prop/rotor system and the primary drive system weight reflect the actual operating tip speed.

The drive system ratings determined in the sizing process may be used to limit helicopter performance by setting Q_{IND} (LOC 1205) = 1.0, and inputting an appropriate value of Q_{MAX}/Q^*, LOC 1224. This option imposes a transmission torque limit in the performance calculations.

Figure 4-28 is a flow chart of the Engine Sizing Subroutine



PAGE 2
ENGSZ

Figure 4-28. Engine Sizing Subroutine, Flow Chart (Part 1 of 12)

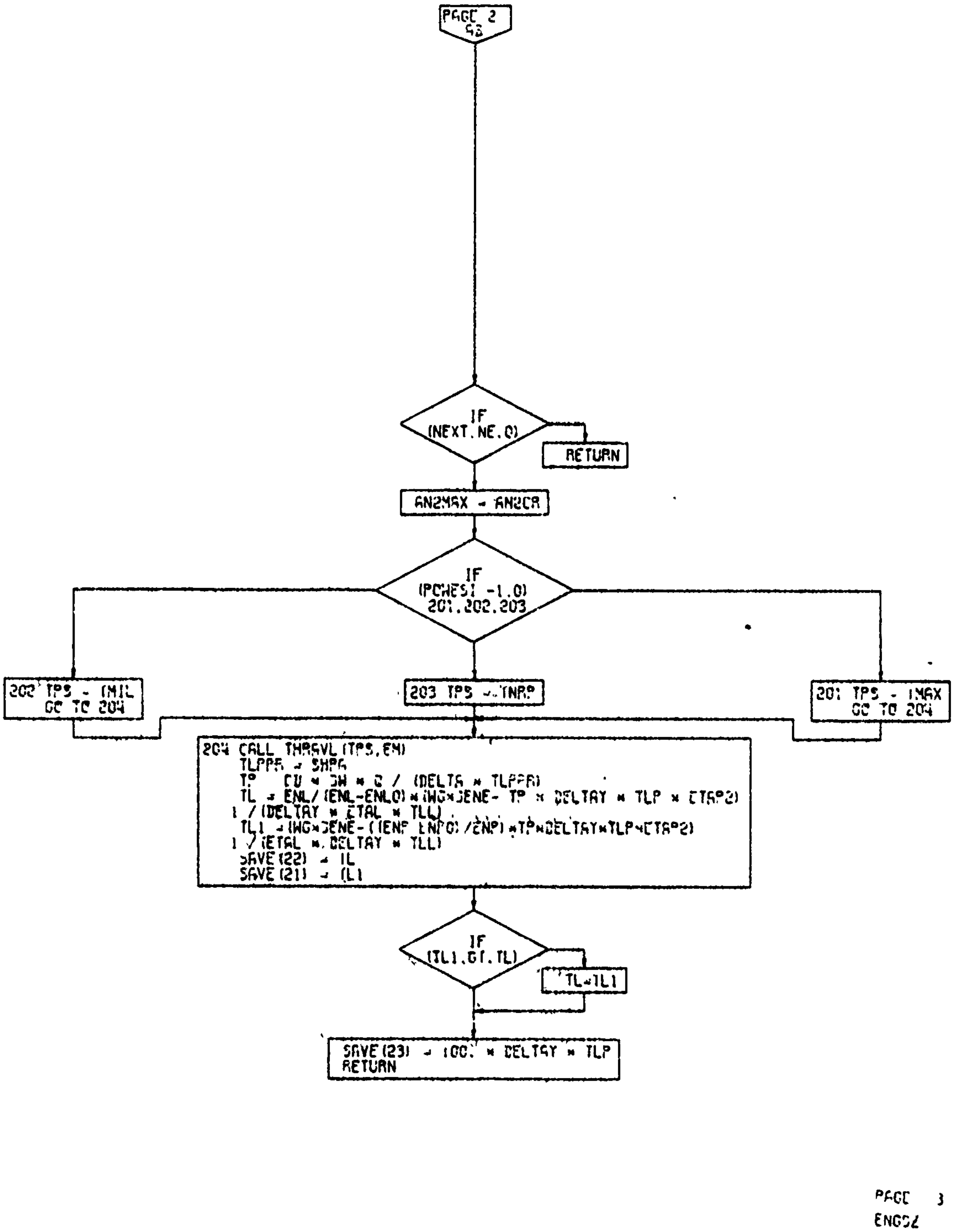


Figure 4-28. Engine Sizing Subroutine, Flow Chart
(Part 2 of 12)

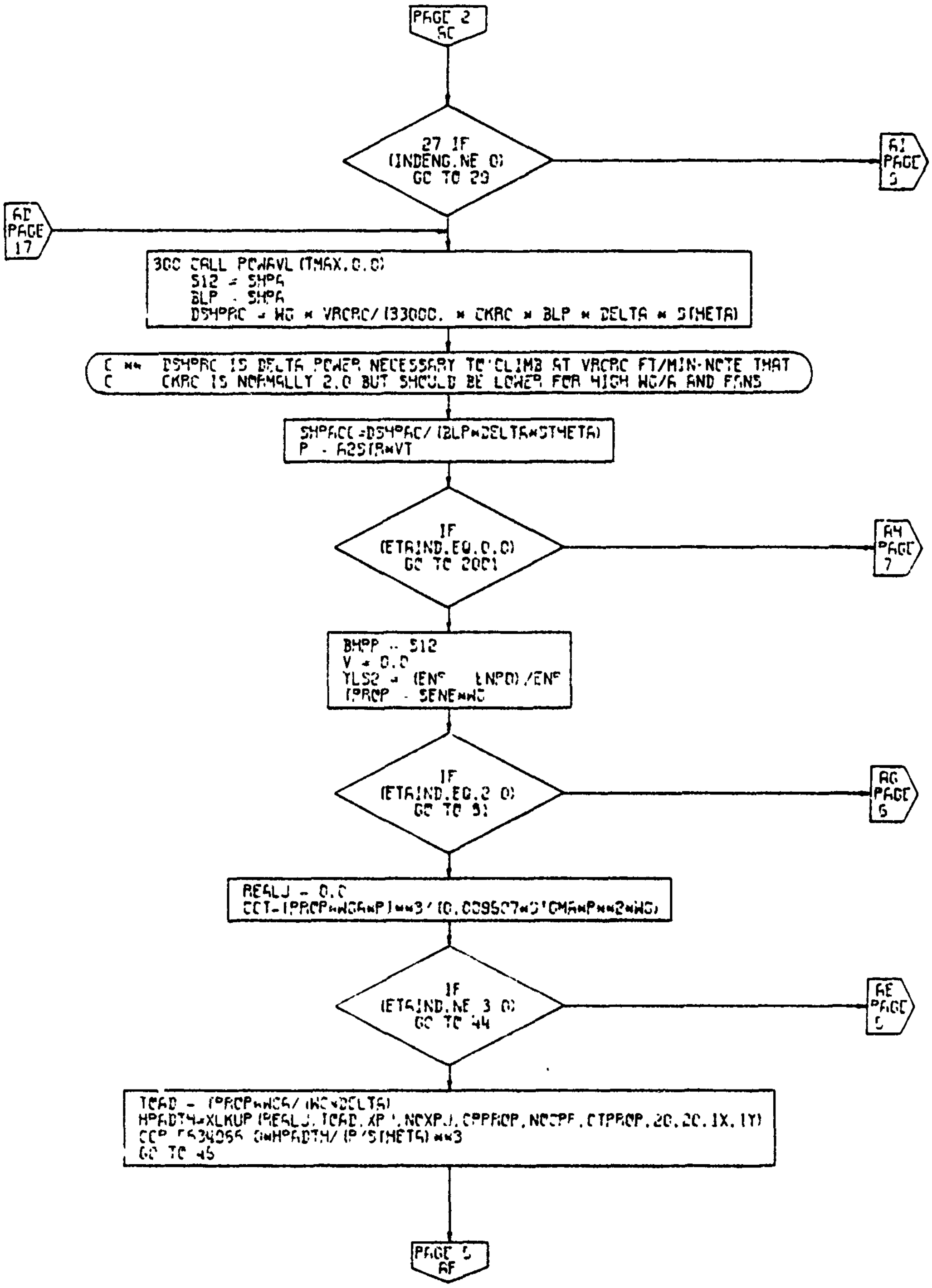


Figure 4-28. Engine Sizing Subroutine, Flow Chart (Part 3 of 12)

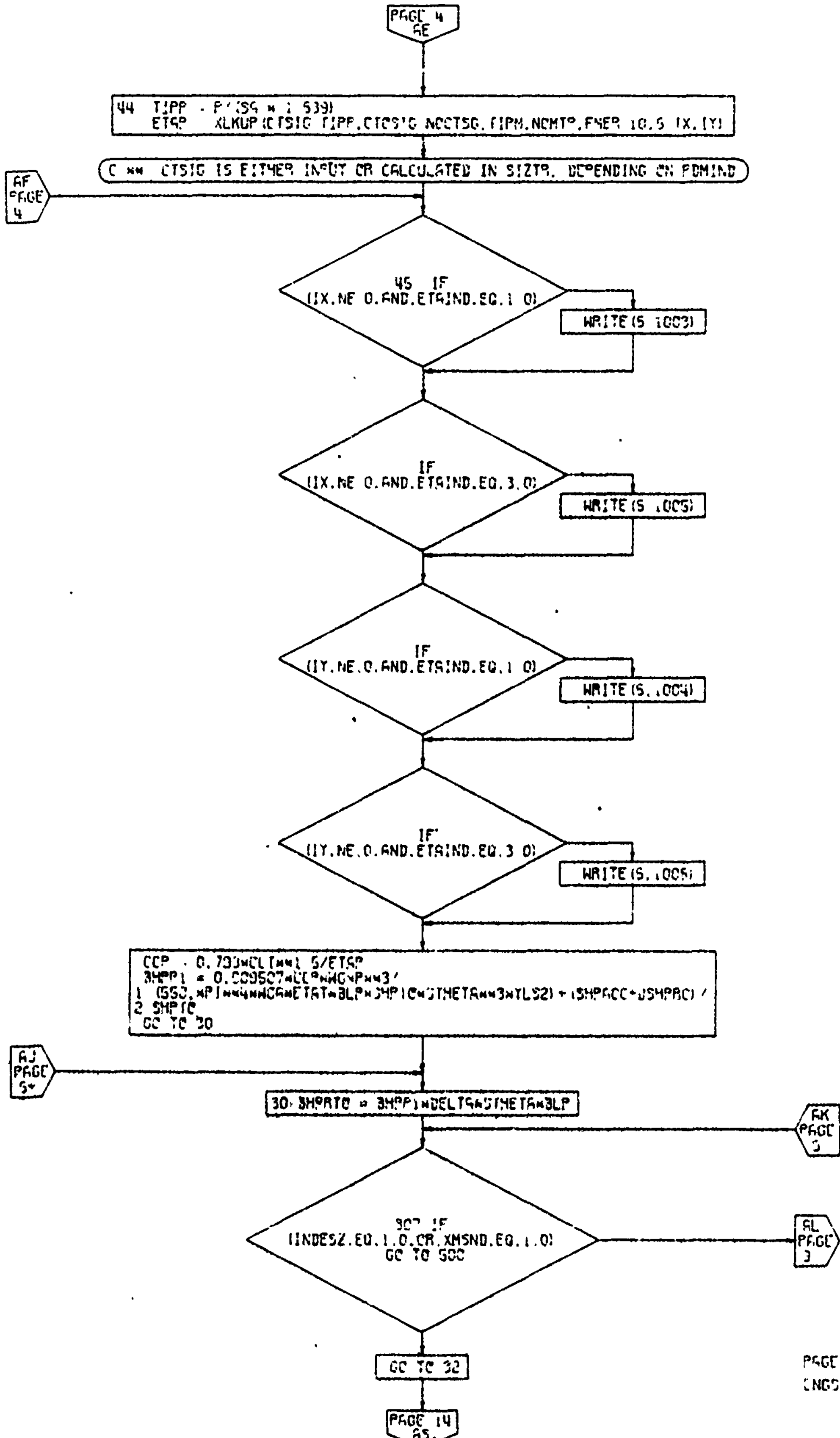
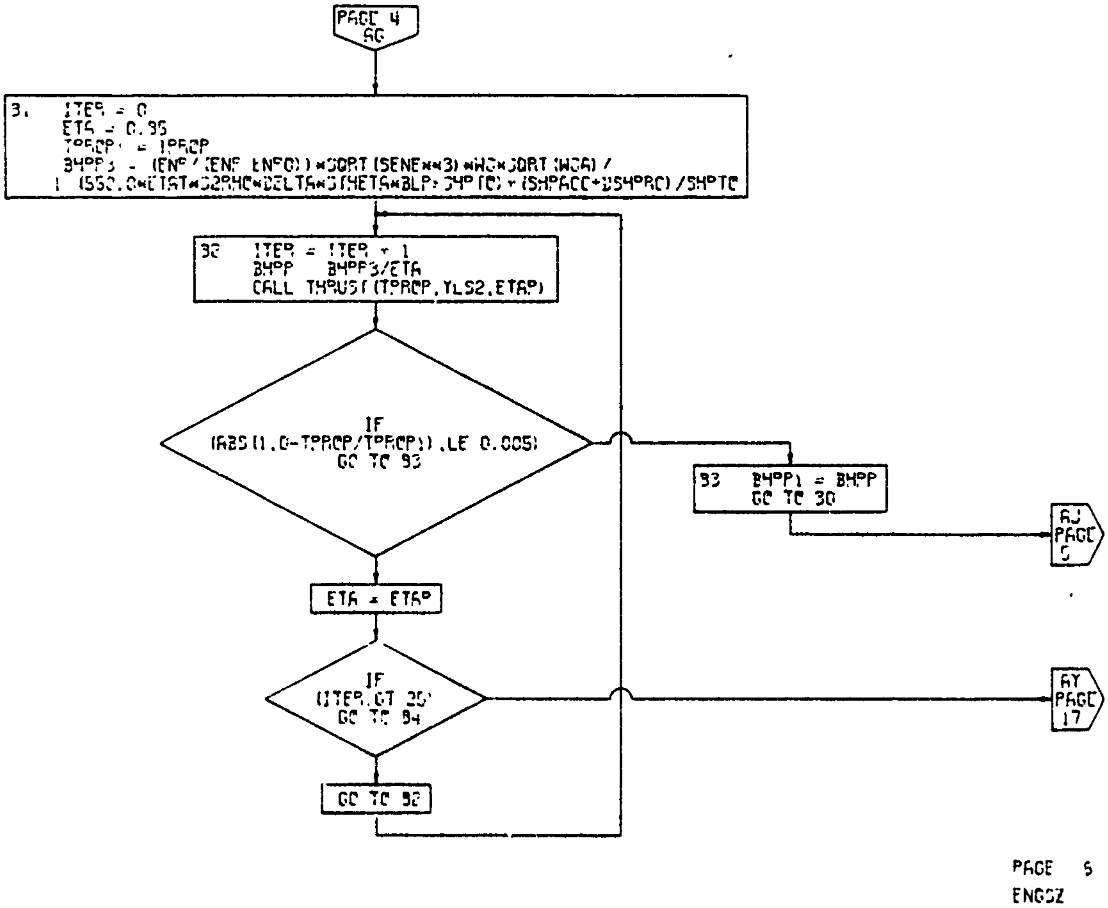


Figure 4-28. Engine Sizing Subroutine, Flow Chart (Part 4 of 12)



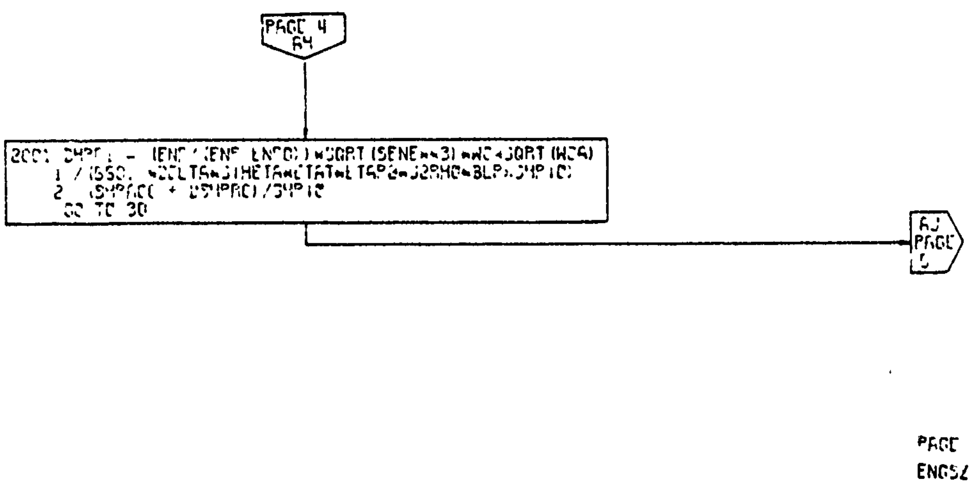


Figure 4-28. Engine Sizing Subroutine, Flow Chart
(Part 5 of 12)

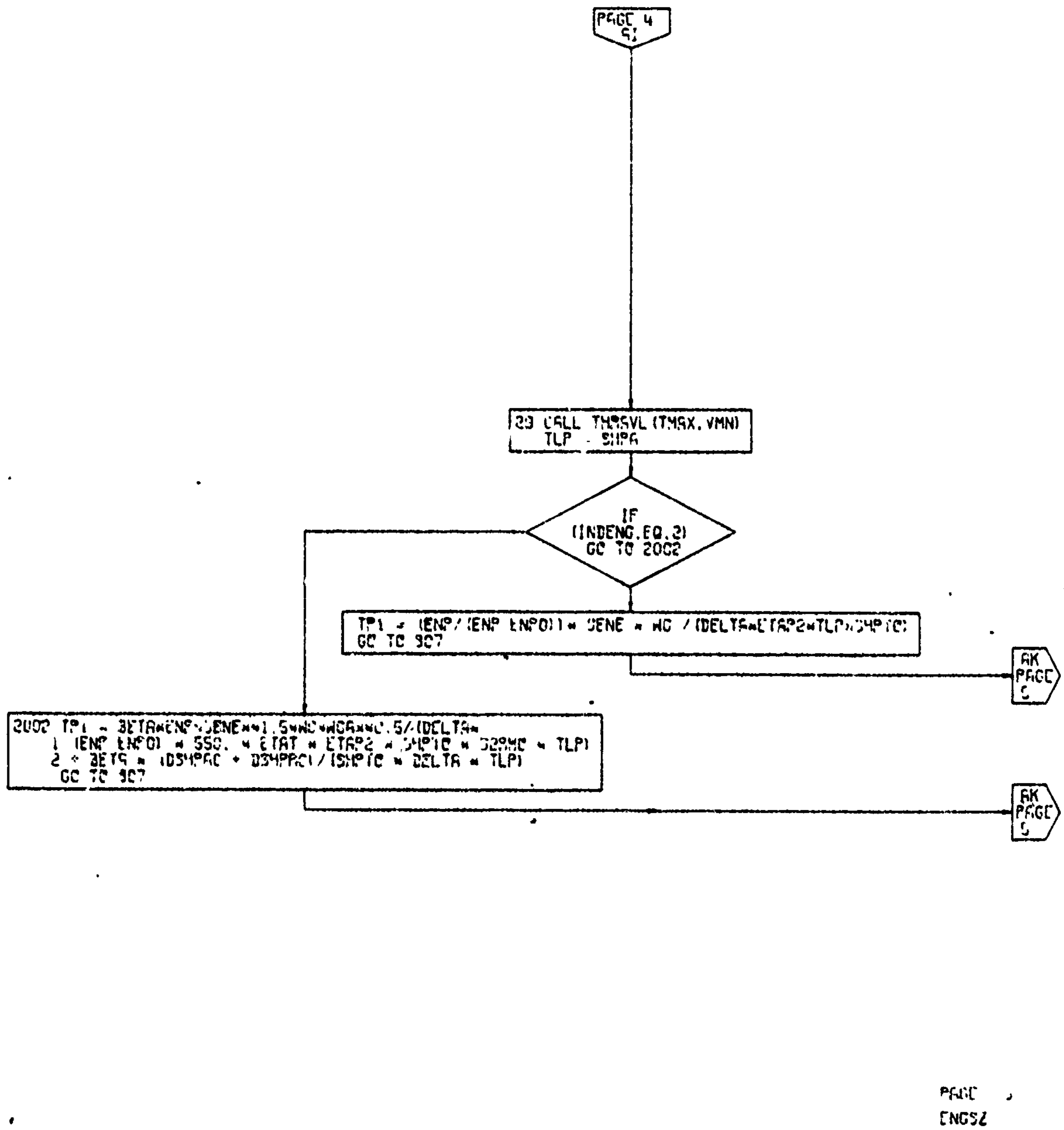


Figure 4-28. Engine Sizing Subroutine, Flow Chart
(Part 6 of 12)

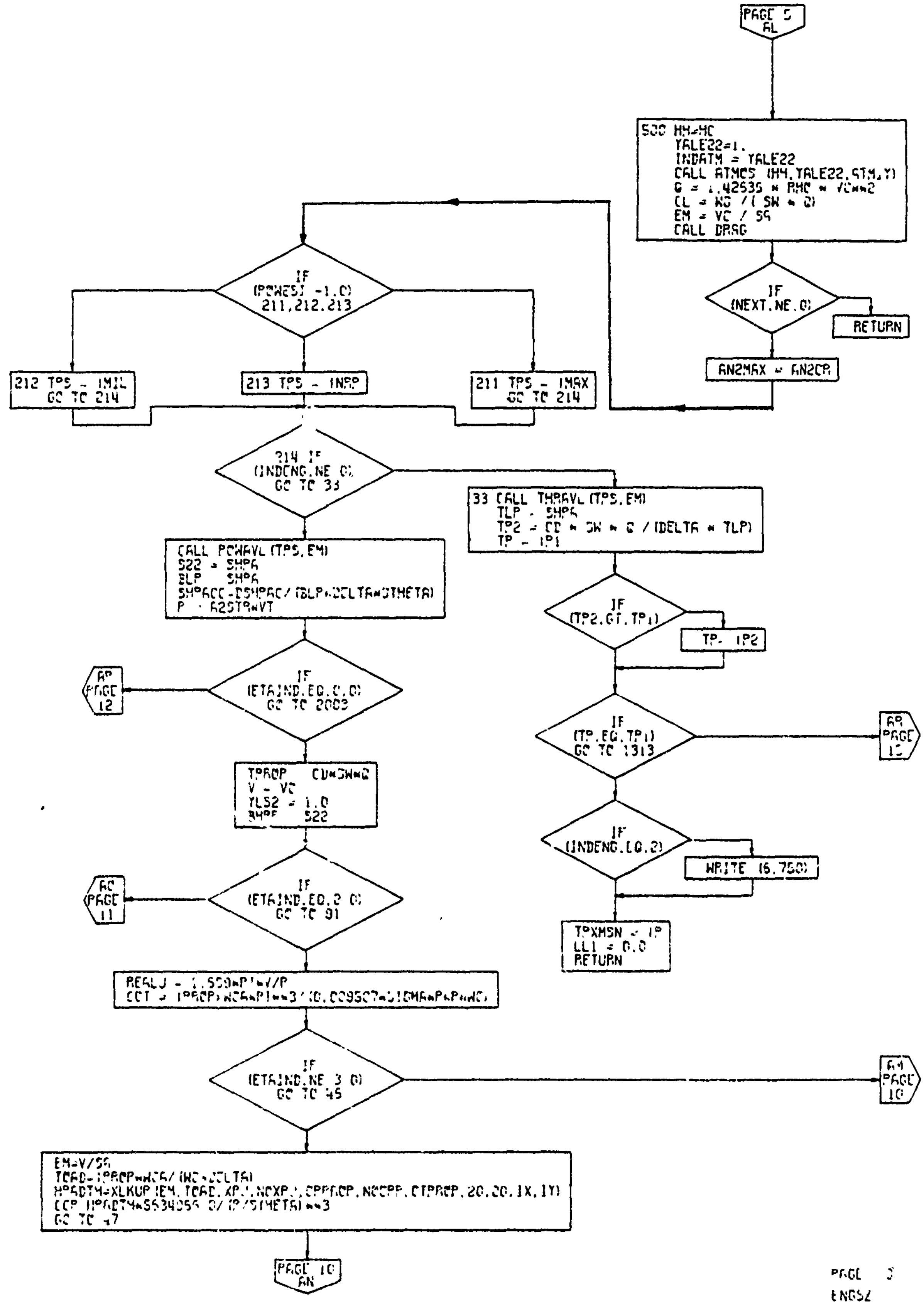


Figure 4-28 Engine Sizing Subroutine, Flow Chart
(Part 7 of 12)

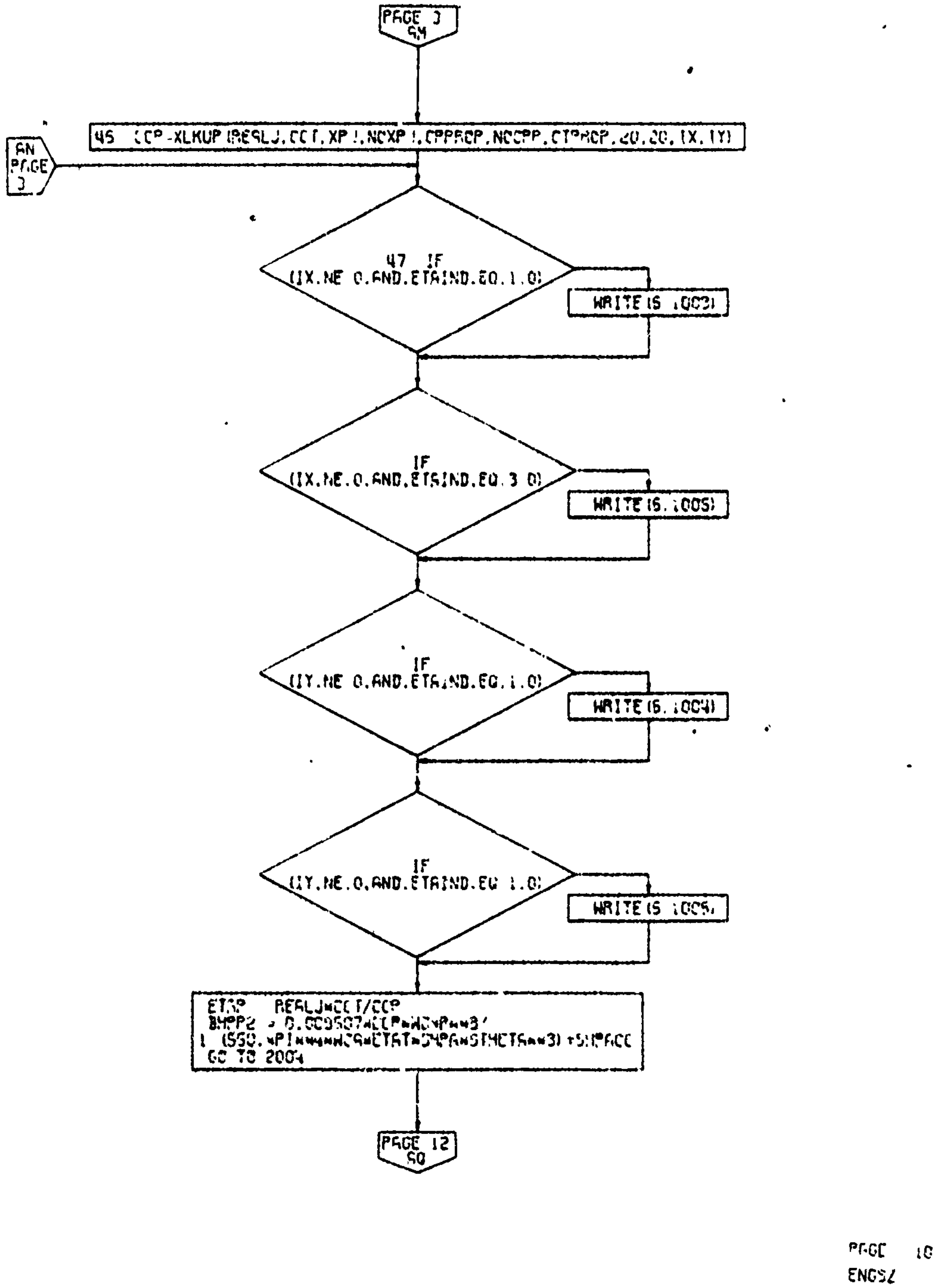


Figure 4-28. Engine Sizing Subroutine, Flow Chart
(Part 8 of 12)

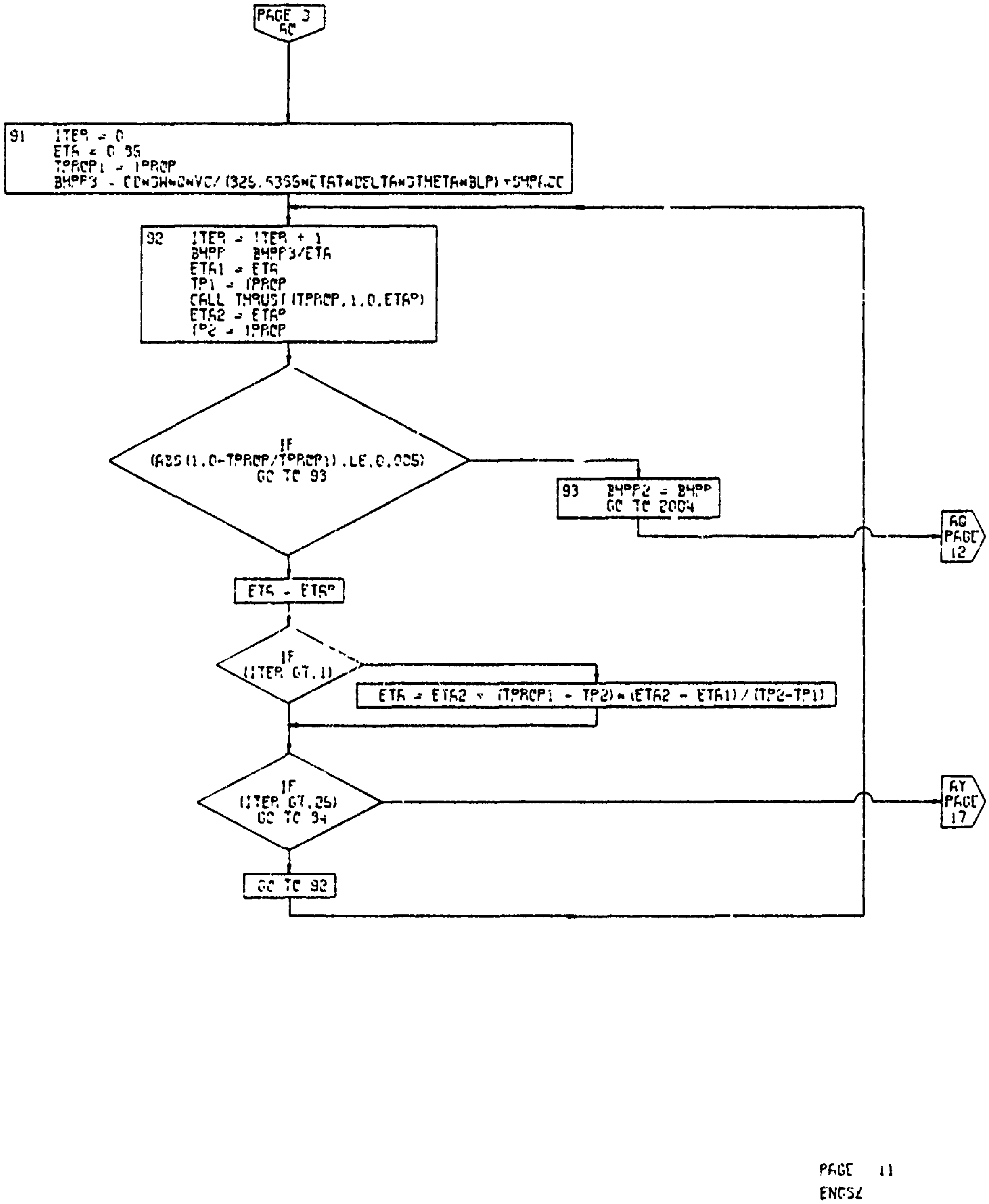
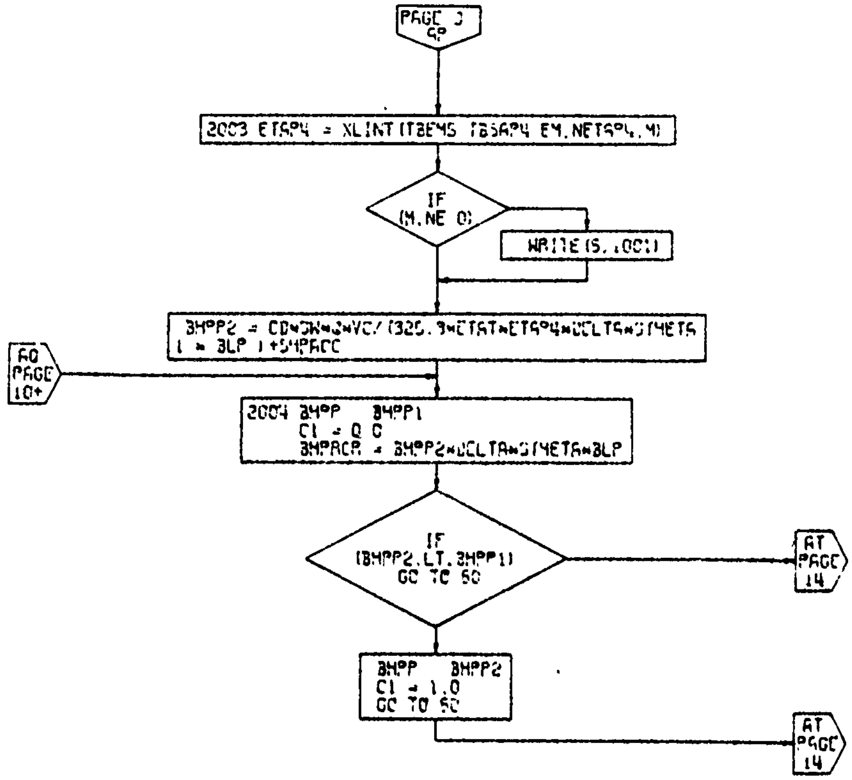


Figure 4-28. Engine Sizing Subroutine, Flow Chart
(Part 9 of 12)



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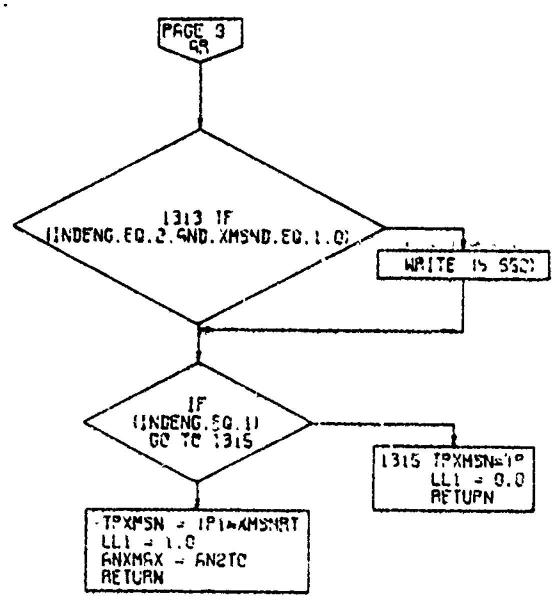

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Figure 4-28. Engine Sizing Subroutine, Flow Chart (Part 10 of 12)

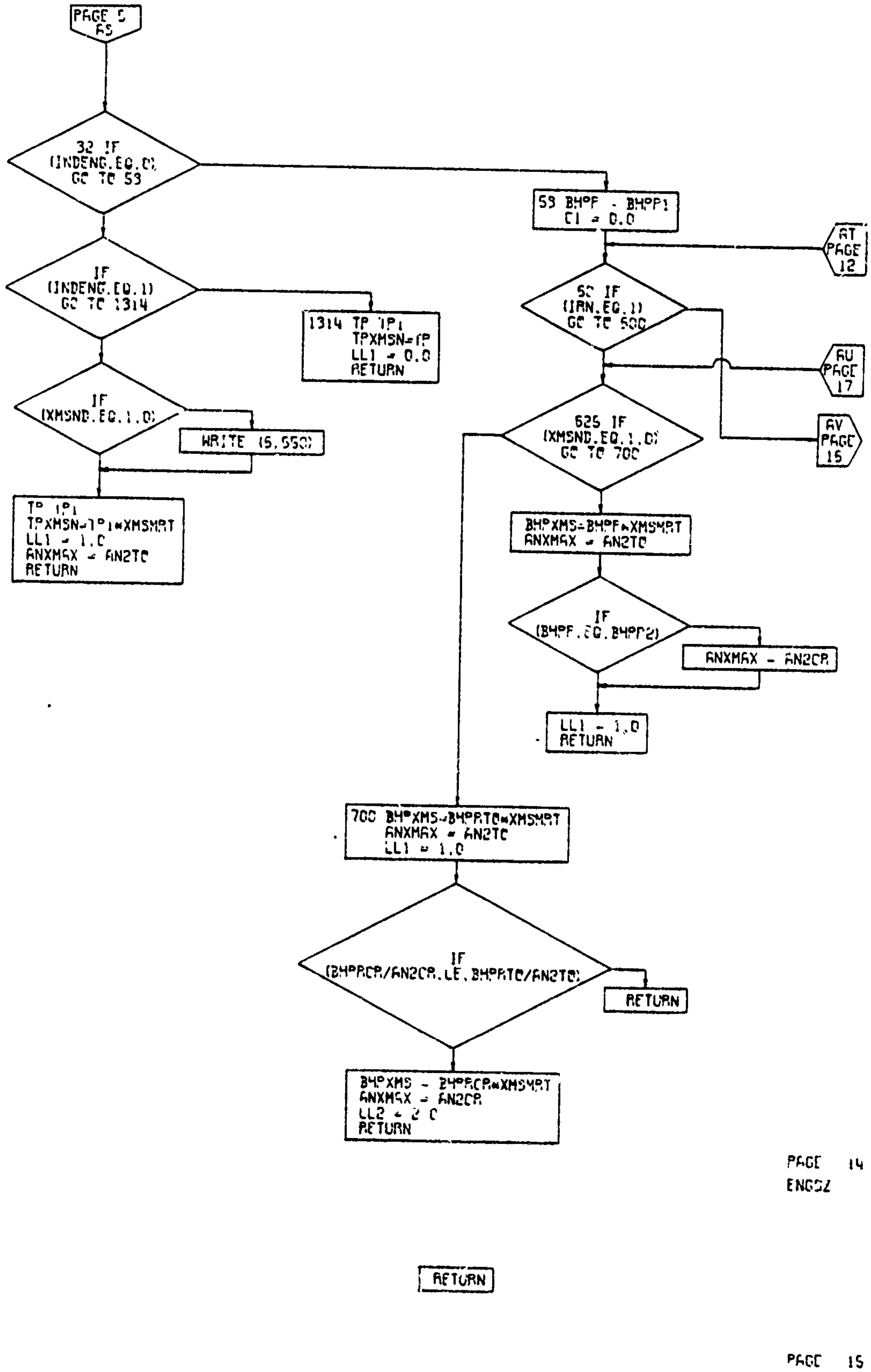
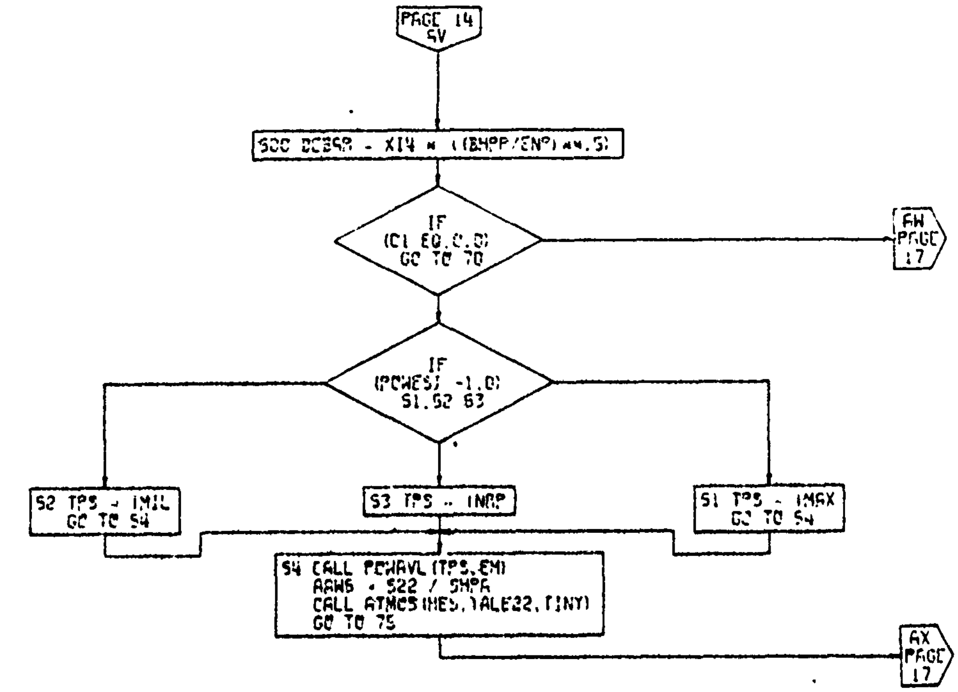
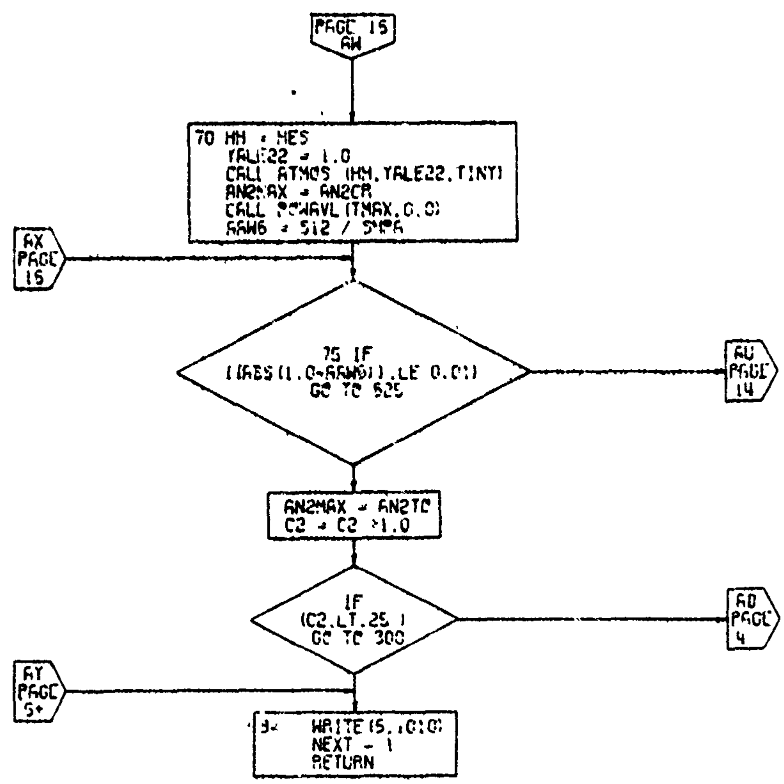


Figure 4-28. Engine Sizing Subroutine, Flow Chart (Part 11 of 12)



PAGE 16
ENGSZ



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ENGSZ

Figure 4-28. Engine Sizing Subroutine, Flow Chart
(Part 12 of 12)

4.9 WEIGHT TRENDS SUBROUTINE

The weight trends subroutine calculates the group weights for the propulsion system, the structures system, and the flight control system. These weights are then combined with input values of the weight of fixed useful load, fixed equipment, and payload in order to determine the weight of fuel available (Figure 4-29). The subroutine uses detailed statistical weight equations as used at the Boeing Vertol Company. The group weights are not directly added, but rather are combined by the use of incremental multiplicative and additive weight factors; these factors are useful for sensitivity studies for the aircraft. For example, if it is desired to determine the effect of an additional 300 pounds of propulsion system weight, the factor ΔW_p is input as 300. Similarly, if it is desired to investigate the effect of a 15-percent increase in the weight of the engines, the factor K_5 is input as 1.15.

In order to calculate the weight of the aircraft structure, the weight trends subroutine must determine the limiting design load factor. It does this by comparing the magnitude of the input maneuver load factor with the value calculated for gust load factor. The gust load factor is evaluated at the altitude at which maximum operating equivalent airspeed (V_{MO}) is equal to the speed for maximum operating Mach number (M_{MO}) so long as the altitude falls in the band,

$$0 \leq h_{CRIT} \leq 20{,}000 \text{ feet} \quad .$$

The gust load factor is calculated at the speed V_C (see Reference 4) which is taken to be equal to V_{MO}/M_{MO}. Modern aircraft which would be studied by VASCOMP II are seldom, if ever, gust-critical at either the V_B or V_D (Reference 4) conditions. If the user finds that his aircraft is gust-critical at other than the V_C condition, he must manually calculate the expected load factor and insert that value in the program as a dummy maneuver load factor.

4.9.1 Weight Trend Data

The weights subroutine section of VASCOMP presented herein represents one approach for determining the individual and group weights which make up the weight empty of an aircraft. The aircraft weight is divided into the subgroups as shown in Table 4-7 and is in general accordance with the weight and balance data reporting procedures and forms for aircraft and rotorcraft described in Military Standard 1374. A copy of Part I (Group Weight Statement) is included at the end of this section. A flow chart describing the weights subroutine is shown in Figure 4-30.

WEIGHT TRENDS SUBROUTINE

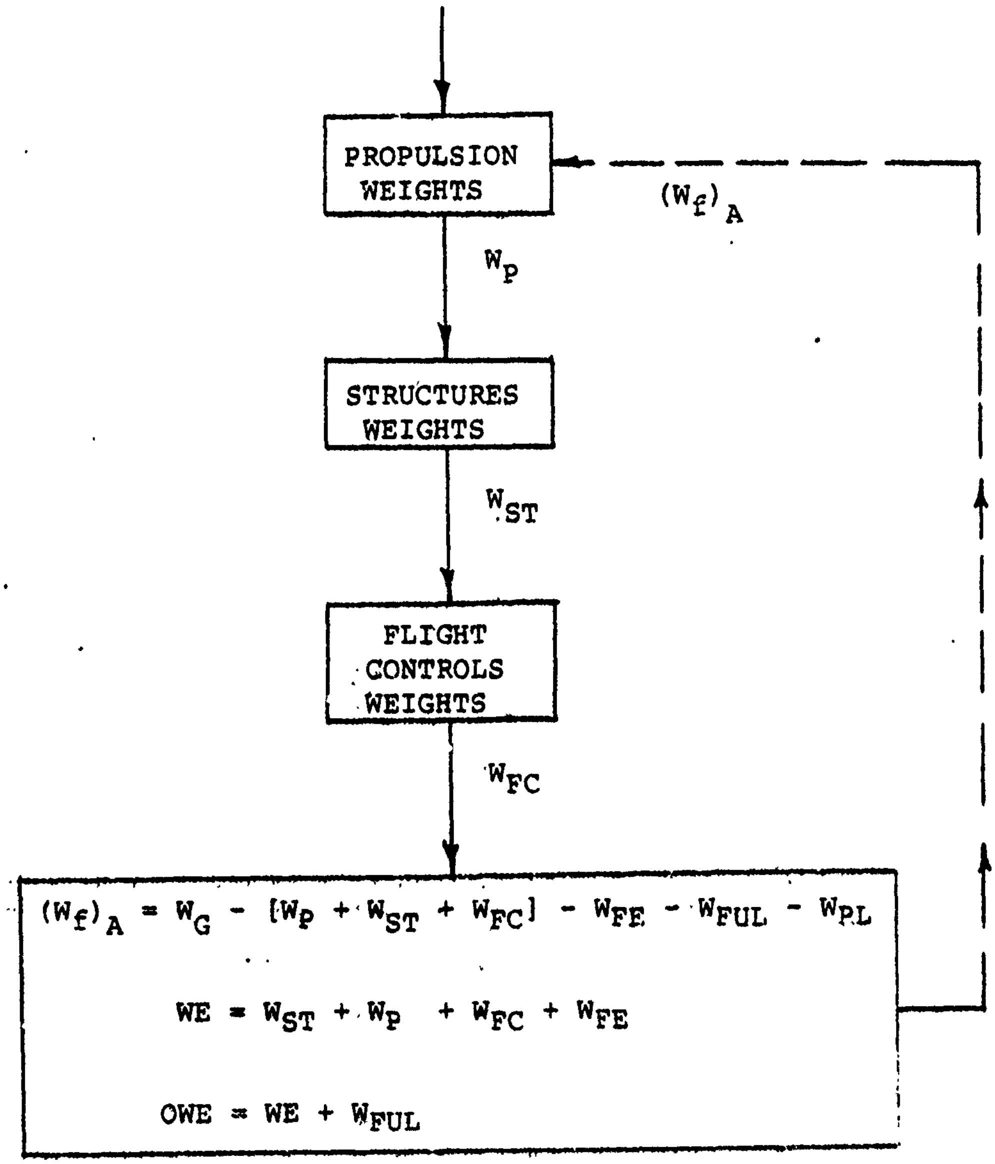


Figure 4-29. Weight Trends Schematic

BOEING VERTOL COMPANY

WEIGHT SUMMARY - PRELIMINARY DESIGN
(MIL-STD-1374)

TABLE 4-7
WEIGHT SUMMARY FORM

WING	1					
ROTOR	2					
TAIL	3					
SURFACES	4					
ROTOR	5					
BODY	6					
BASIC	7					
SECONDARY	8					
ALIGHTING GEAR GROUP	9					
ENGINE SECTION	10					
	11					
PROPULSION GROUP	12					
ENGINE INST'L	13					
EXHAUST SYSTEM	14					
COOLING	15					
CONTROLS	16					
STARTING	17					
PROPELLER INST'L	18					
LUBRICATING	19					
FUEL	20					
DRIVE	21					
FLIGHT CONTROLS	22					
	23					
AUX. POWER PLANT	24					
INSTRUMENTS	25					
HYDR. & PNEUMATIC	26					
ELECTRICAL GROUP	27					
AVIONICS GROUP	28					
ARMAMENT GROUP	29					
FURN. & EQUIP. GROUP	30					
ACCOM. FOR PERSON.	31					
MISC. EQUIPMENT	32					
FURNISHINGS	33					
EMERG. EQUIPMENT	34					
AIR CONDITIONING	35					
ANTI-ICING GROUP	36					
LOAD AND HANDLING GP.	37					
	38					
	39					
	40					
	41					
WEIGHT EMPTY						
CREW						
TRAPPED LIQUIDS						
ENGINE OIL						
Pass. Service Items						
FUEL						
GROSS WEIGHT						

REV.

FORM 26391 (2/73)

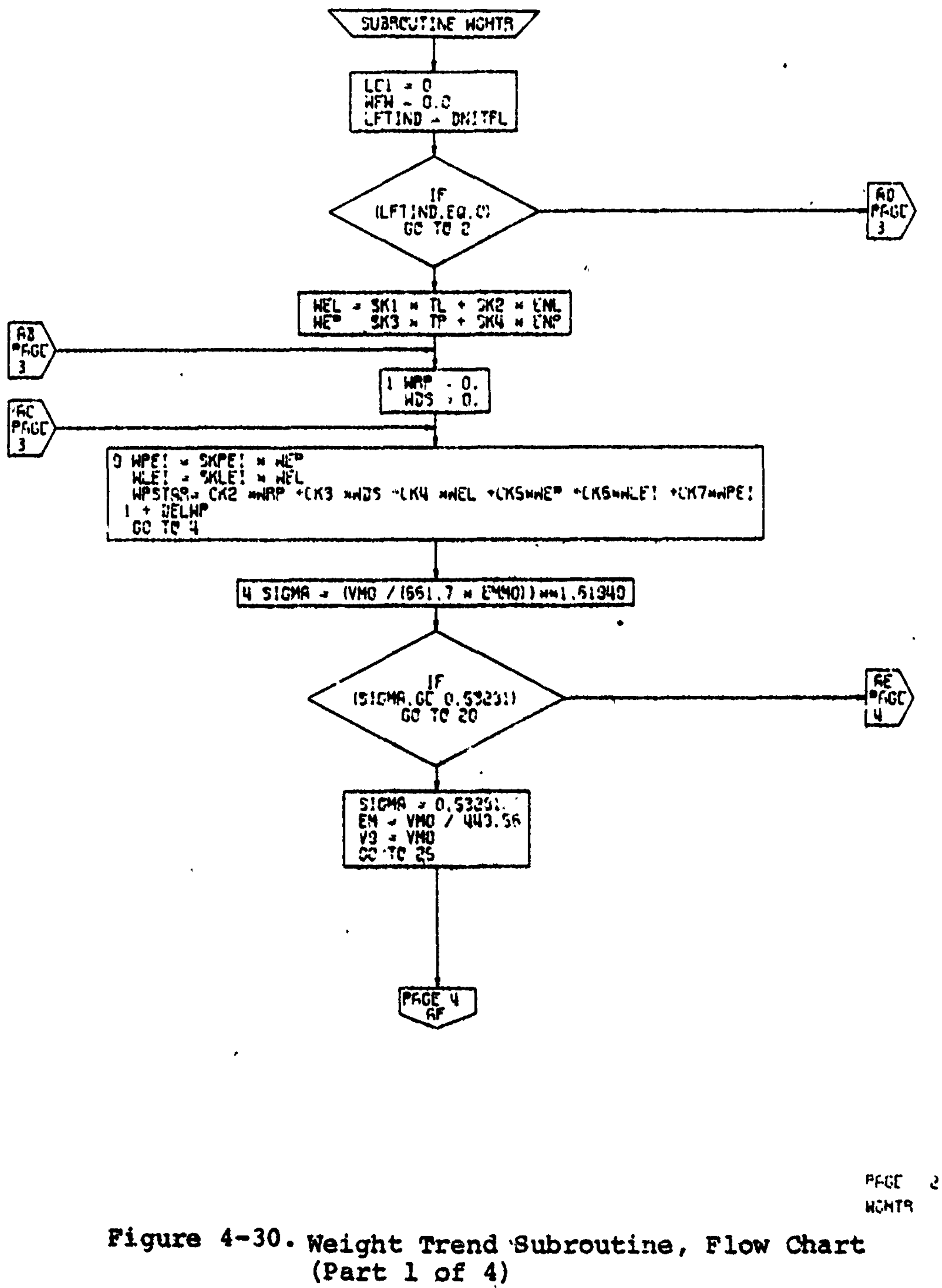
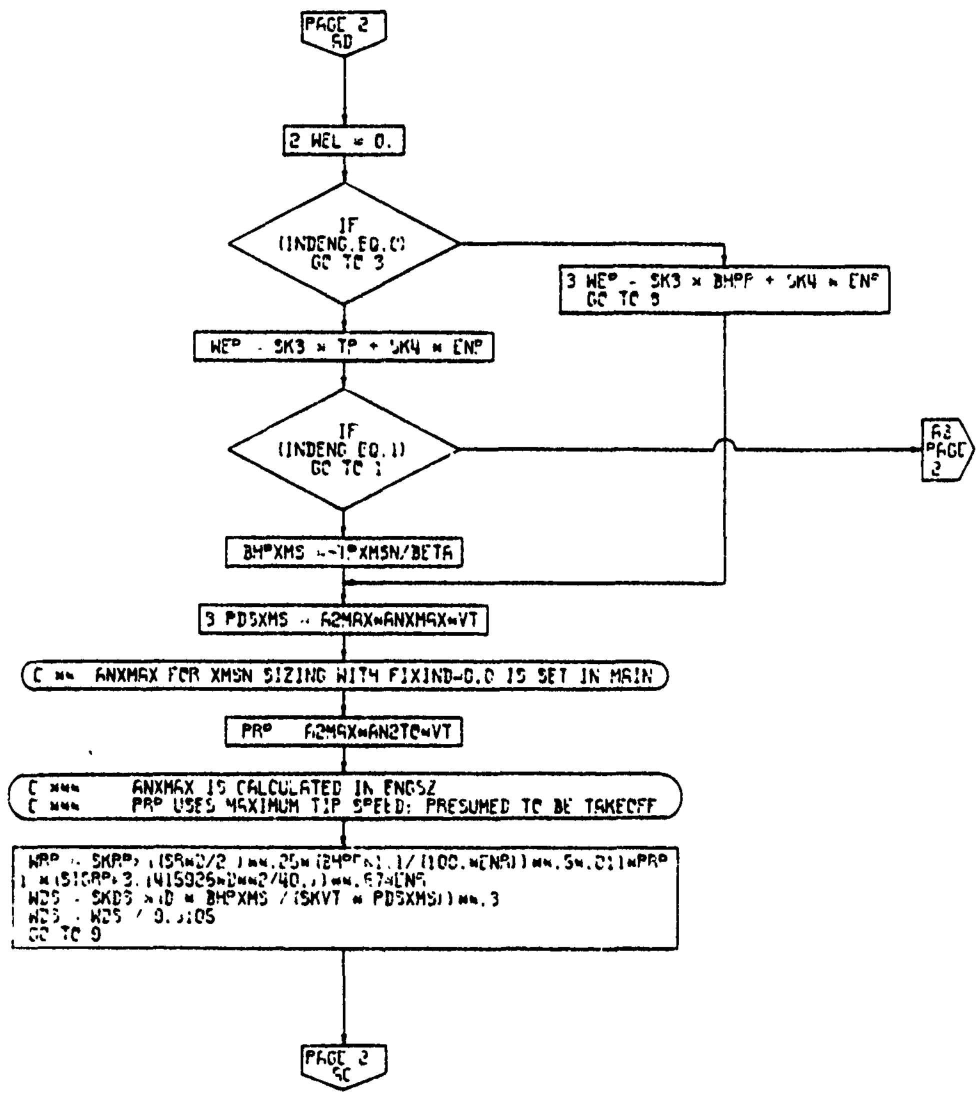


Figure 4-30. Weight Trend Subroutine, Flow Chart (Part 1 of 4)



PAGE 3
WGHTR

Figure 4-30. Weight Trend Subroutine, Flow Chart (Part 2 of 4)

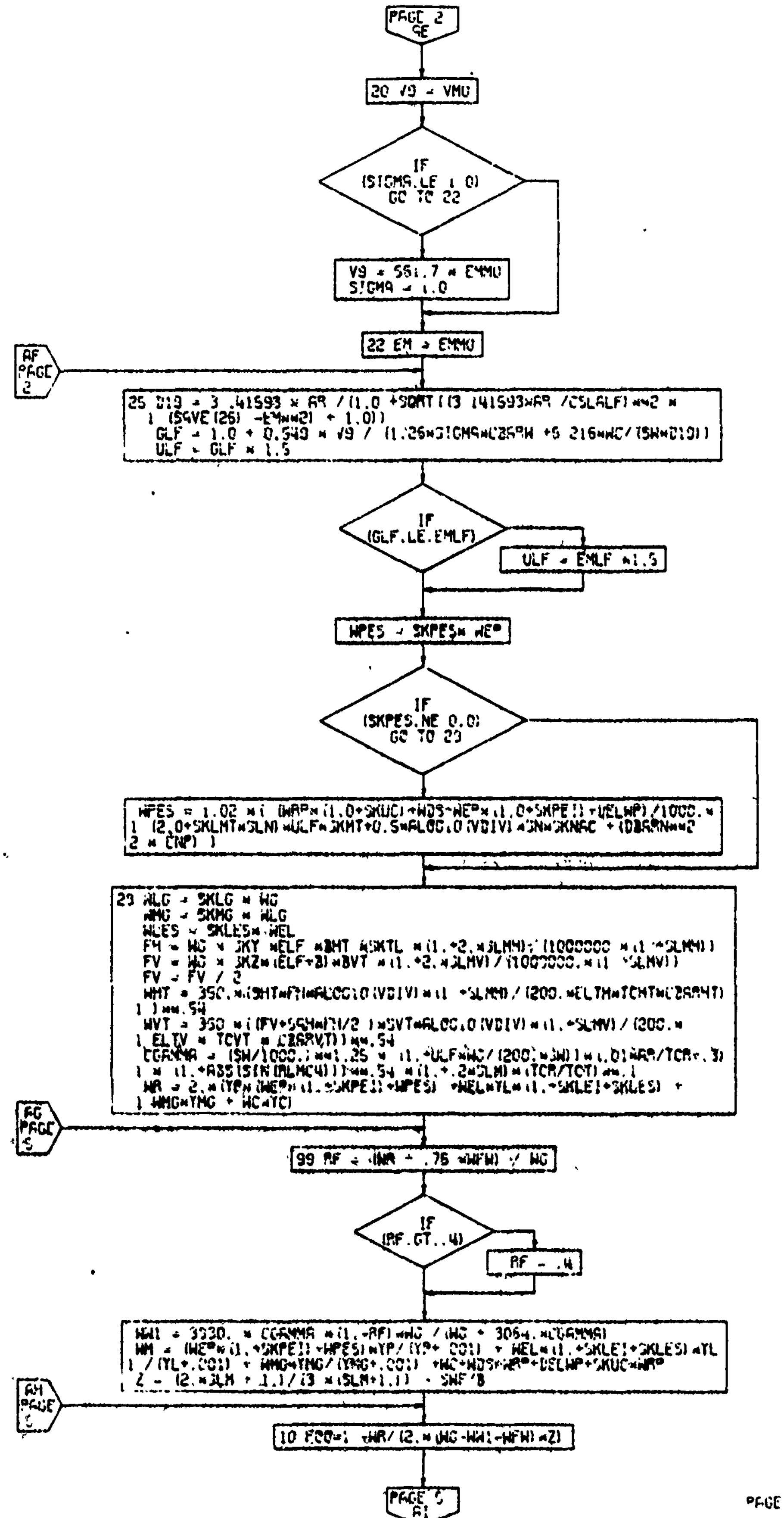


Figure 4-30. Weight Trend Subroutine, Flow Chart (Part 3 of 4)

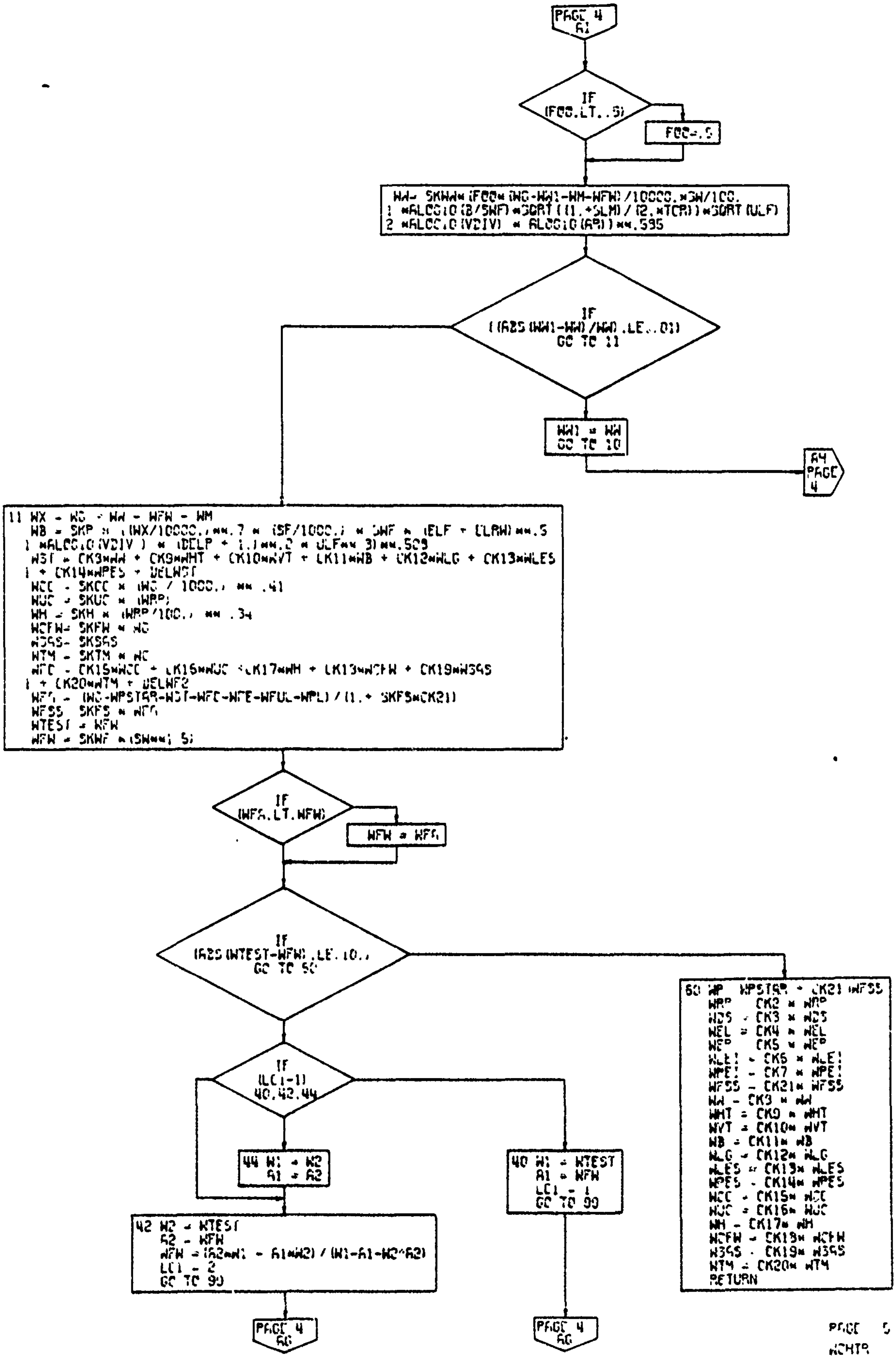


Figure 4-30. Weight Trend Subroutine, Flow Chart (Part 4 of 4)

The trend equations shown on the weights subroutine flow chart and those presented in the text produce the same results, although they are not necessarily written in the same form. The flow chart equations express the text trends in the terms used in other parts of the computer program.

The primary purpose of this weights subroutine is to provide a consistent method for rapidly estimating the operational weight empty and fuel available for the missions of various types of V/STOL aircraft. The results obtained from the trend equations will largely depend on engineering experience and the judgment exercised in selecting the various trend constants presented. The weight trend equations for the rotor, wing, tails, body, drive system, and pitch and yaw radius of gyration were developed by A. H. Schmidt of the Boeing Vertol Company over a span of 10 years. R. H. Swan, Chief Weight Engineer at Boeing Vertol, assisted in developing the rotor and wing equations. Accuracy of the trends is estimated to be within 5 percent of the actual values.

An explanation of the weight trends and instructions for completing the weight input sheet of VASCOMP are included in the text. As an additional aid for filling out the weight input sheet, the page numbers defining the various k terms are included with the respective terms on the weight input sheet, Table 4-8.

Weight trends developed at Boeing Vertol were used to determine the structure weights, Table 4-7, items 1, 3, and 6; flight control weights, item 22; and the propulsion system weights, items 2, 18, and 21. The trends were developed from existing aircraft and use design and geometric parameters to compute the weights of the various components. For aircraft on which limited information is available, such as in the case of the lift-fans, jet-lift, tilt-wing, etc., the trend constants have been adjusted to account for the design features typical of the particular configuration. Alighting gear weights are a function of the takeoff weight and are based on statistically derived percentages of the respective gross weights. Engine weights, item 13, were determined from information compiled from engine manufacturers. Engine section and engine installation weights, Table 4-7, items 10, 14, 15, 16, 17, and 19, are expressed as a percentage of the dry engine weight. Fixed equipment weights, items 24 through 41, are discussed later in the text.

Table 4-7 is representative of a typical weight summary form used for military aircraft. For this report the same general form will be used for commercial aircraft, with additions and revisions described in the group in which they occur. Definitions of some of the weight terms used are presented below.

SHEET NO.	CASE NO.
OF	

WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

AIRCRAFT WEIGHT INFORMATION

TABLE 4-8

	VARIABLE	LOC	VALUE
†	OWE	0400	Page 4-172
	W_{FE} LBS	0401	Page 4-172
	W_{FUL} LBS	0402	Page 4-172
††	W_{PL} LBS	0403	Page 4-174

FLIGHT CONTROLS

k_{CC}	0404	Page 4-159
k_{FW}	0405	Page 4-163
k_H	0406	Page 4-159
k_{SAS}	0407	Page 4-163
k_{TM}	0408	Page 4-163
k_{UC}	0409	Page 4-159

† OWE IS NOT NECESSARY WHEN OPTIND = 1,2

†† W_{PL} IS NOT NECESSARY WHEN OPTIND = 2

INCREMENTAL GROUP WTS. NOM = 0

VARIABLE	LOC	VALUE
ΔW_{FC} LBS	0417	Page 4-159
ΔW_P LBS	0418	Page 4-174
ΔW_{ST} LBS	0419	Page 4-174

GROUP WEIGHT INFORMATION

STRUCTURAL

	k_B	0420	Page 4-151
*	k_{LES}	0421	Page 4-166
	k_{LG}	0422	Page 4-157
	k_{MG}	0423	Page 4-157
	k_{TL}	0424	Page 4-151
	k_{WF}	0425	Page 4-146
	k_{WW}	0426	Page 4-146
	k_Y	0427	Page 4-151
	k_Z	0428	Page 4-151
	k_{PES}	0429	Page 4-166
	k_{MT}	0430	Page 4-166
	k_{NAC}	0431	Page 4-166
	ℓ_{MT}	0432	Page 4-166

TO USE k_{MT}, k_{NAC}, & ℓ_{MT} INPUT k_{PES}=0 IF k_{PES} IS INPUT AS NON-ZERO, k_{MT}, k_{NAC}, AND ℓ_{MT} ARE NOT REQUIRED.

VARIABLE	LOC	VALUE
ΔP P.S.I.	0450	Page 4-157
W_C LBS.	0451	Page 4-146
Y_C	0452	Page 4-146

PROPULSION

**	k_{DS}	0453	Page 4-168
	k_{FS}	0454	Page 4-168
*	k_{LEI}	0455	Page 4-166
	k_{PEI}	0456	Page 4-166
**	(†)$k_{R/P}$	0457	Page 4-144
**	k_{VT}	0458	Page 4-172

* NOT NECESSARY WHEN LFTIND = 0

** NOT NECESSARY WHEN ENGIND = 1

(†) INPUT AS 0 IF η_{PIND} (LOC 0200) = 3

MULTIPLICATIVE FACTORS NOMINALLY = 1.0

K_{15}	0410	Page 4-176
K_{16}	0411	Page 4-176
K_{17}	0412	Page 4-176
K_{18}	0413	Page 4-176
K_{19}	0414	Page 4-176
K_{20}	0415	Page 4-176

K_8	0433	Page 4-176
K_9	0434	Page 4-176
K_{10}	0435	Page 4-176
K_{11}	0436	Page 4-176
K_{12}	0437	Page 4-176
K_{13}	0438	Page 4-176
K_{14}	0439	Page 4-176

K_2	0459	Page 4-176
K_3	0460	Page 4-176
K_4	0461	Page 4-176
K_5	0462	Page 4-176
K_6	0463	Page 4-176
K_7	0464	Page 4-176
K_{21}	0465	Page 4-176

ATMOSPHERE TEMPERATURE

NO. OF PAIRS	0416	

NOTE: THIS TABLE IS NOT NECESSARY IF ATMIND IS NEVER SET TO 2

Refer to Table 4-15 for a description of the multiplicative factors.

h_1 FT	0440	
h_2 FT	0441	
h_3 FT	0442	
h_4 FT	0443	
h_5 FT	0444	
h_6 FT	0445	
h_7 FT	0446	
h_8 FT	0447	
h_9 FT	0448	
h_{10} FT	0449	

θ_1	0466	
θ_2	0467	
θ_3	0468	
θ_4	0469	
θ_5	0470	
θ_6	0471	
θ_7	0472	
θ_8	0473	
θ_9	0474	
θ_{10}	0475	

Takeoff Gross Weight

Takeoff gross weight consists of the following subweights:

- Weight Empty

  Weight empty includes a completely assembled aircraft ready to fly including the fluids required to operate the various systems such as in the transmissions and hydraulic systems. It does not include the trapped and unusable oil in the engine system or the trapped and unusable fuel in the fuel system.

- Fixed Useful Load

  Crew and crew luggage (includes stewardesses)
  Trapped liquids (unusable fuel and oil)
  Engine oil
  Passenger service items (commercial aircraft)

  - Water (wash and drink)
  - Beverage
  - Galley or coffee bar
  - Toilet chemicals
  - Food trays
  - Emergency equipment (portable oxygen equipment, escape chute, smoke goggles, etc.)

- Payload

  Gross weight less weight empty, fixed useful load, and fuel.

- Fuel

  As required for mission.

Operating Weight Empty and Useful Load

Items included in the operating weight empty and the useful load are shown below:

$$
\left.\begin{array}{l}\text{OPERATING} \\ \text{WEIGHT EMPTY}\end{array}\right.
\text{———}
\left\{\begin{array}{l}\text{Weight Empty} \\ \text{Fixed Useful Load}\end{array}\right.
\qquad
\left.\begin{array}{l}\text{Fixed Useful Load} \\ \text{Payload} \\ \text{Fuel}\end{array}\right\}
\text{———USEFUL LOAD}
$$

The weight data and trend constants included herein are representative of the 1970-1975 time period. A description and explanation of the weight trends and other data required to complete the weights input portion of VASCOMP, Table 4-8, follow.

Rotors or Propellers

The weight of the rotors or propellers is derived from the following equation:

$$W_R = 14.2\ a\ (k)^{0.67},$$

$$\text{where } k = [r]^{0.25} \left[\frac{HPr}{100}\right]^{0.5} \left[\frac{Vtl}{100}\right] \left[\frac{R.b.c.}{10}\right] \left[\frac{R^{1.6}}{100K_d t}\right]$$

Note: The last term is a droop factor, used only if the result is greater than 1.

Legend

- W_R = weight of rotor or propeller, pounds
- R = rotor radius, feet
- b = no. of blades per rotor
- c = blade chord (average), feet
- HP_r = horsepower (xmsn limit per rotor)
- V_{tl} = design limit tip speed, feet per second
- r = center line of rotation to average blade attachment point, feet

- K_d = droop constant
- t = blade thickness at 0.25R, feet
- "a" = adjusting factor for type of system (see Figure 4-31)

In the trend equation the constant 14.2 is the average for the various rotor group weights presented in Figure 4-31. The expression "a" is the adjustment factor for the type of system, i.e., semirigid, pressure cycle, etc. To determine the value of $k_{R/P}$ in the propulsion block of the weight input sheet, multiply the type of system desired "a" by the constant 14.2. Additional penalties must be added to the 14.2 "a" constant when blade folding and blade stowage are required. Increase the 14.2 "a" constant by an additional 50 percent if these features are included.

Wing

The wing group includes the following general groups:

- Basic structure - upper and lower surfaces cover material, spars, ribs, joints, splices and fasteners
- Secondary structure - fixed leading and trailing edges, tips, nonstructural doors and panels, and wing fold items

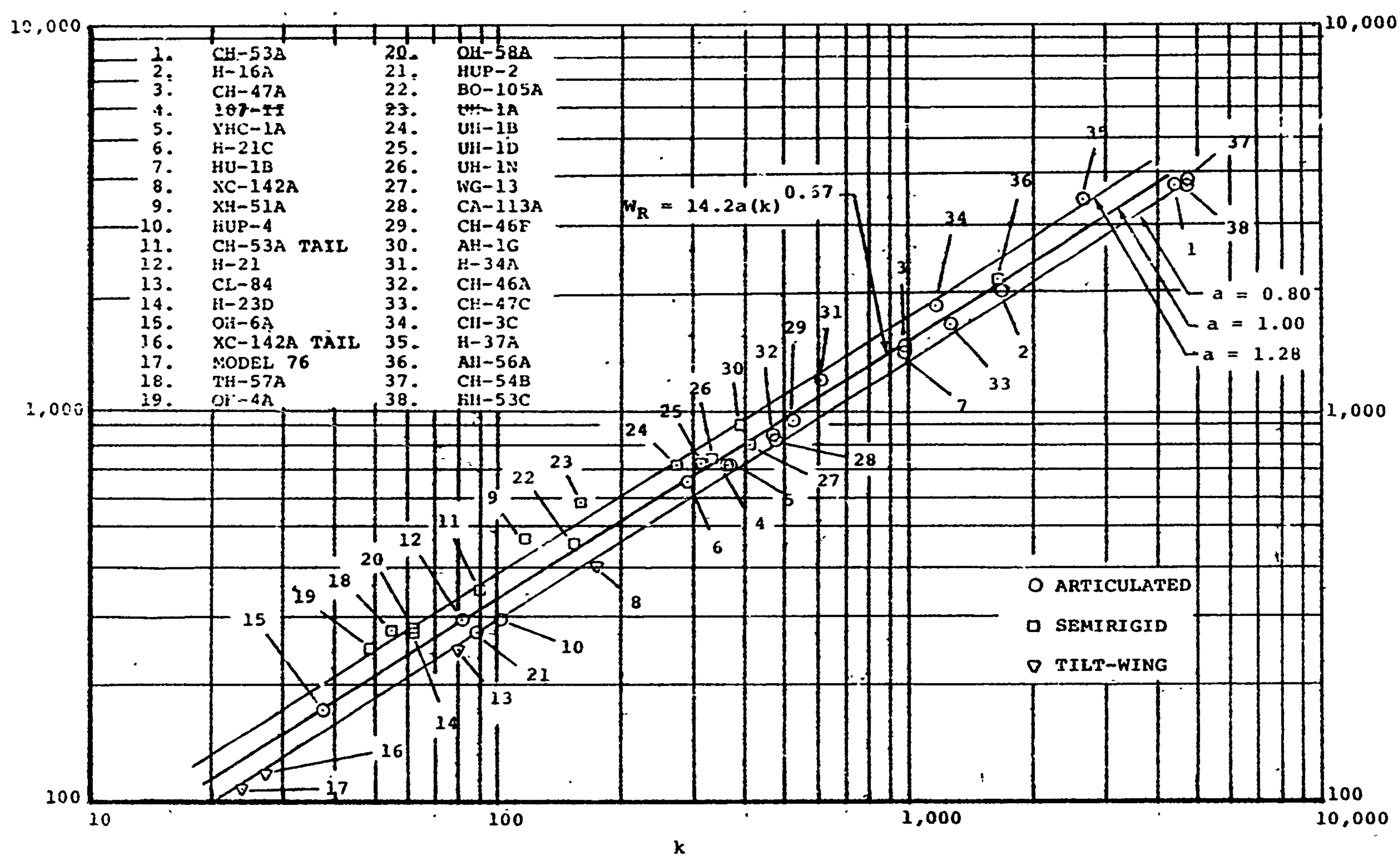


Figure 4-31. Rotor Group Weight Trend.

- Control surfaces - spoilers and ailerons
- High-lift devices - slats, leading and trailing-edge flaps, and boundary-layer-control nozzles and ducting

Wing weights are derived from the following equation:

$$W_W = 220a(k)^{0.585},$$

$$\text{where } k = \left[\frac{RmWx}{10^4}\right]\left[\frac{Sw}{10^2}\right]\left[\log \frac{b}{B}\right]\left[\sqrt{\frac{1+\lambda}{2Kr}}\right]\left[\sqrt{N}\right]\left[\log_{10} V_D\right]\left[\log_{10} AR\right]$$

Legend

W_W = weight of wing, pounds
S_W = planform area of wing (taken from ℄ of aircraft), square feet
b = wingspan, feet
B = maximum fuselage width, feet
λ = taper ratio
N = ultimate load factor
V_D = dive velocity, knots
AR = aspect ratio
k_r = wing root thickness ÷ root chord
W_x = gross weight less wing and items on/in wing, pounds
R_M = relief term = $1 - \dfrac{(\text{dead wt in and on wing})\ (d_2)}{(W_G - \text{wing wt} - \text{wing fuel wt})\ (d_1)}$

d_1 = spanwise dimension from side of body to wing MAC, feet
d_2 = spanwise dimension from side of body to center of concentrated load, feet
W_G = takeoff gross weight, pounds
"a" = adjusting factor for type of wing (see Figure 4-32)

This wing weight equation represents the results of the wings analyzed in Figure 4-32. The 220 constant is an average for the spectrum of aircraft presented on the graph. The "a" factor adjusts the trend accordingly for the type of wing configuration being weighed. The value of k_{WW} to be placed in the structural box of the weight input sheet is the result of "a" times the constant 220. Typical examples of the value "a" are shown in Figure 4-32 . When concentrated loads such as auxiliary fuel tanks, bombs, or other external loads are intended to be suspended from the wing, the W_c and Y_c portions of the incremental block must be filled in. W_c is the total weight of the applied loads and Y_c is its distance, in feet, from the side of the body. The k_{WF} term on the weight input sheet is included to account for the wing bending relief moment resulting from carrying fuel in the wing. The value of k_{WF} will vary between 0 and 0.7 depending on the amount of fuel estimated

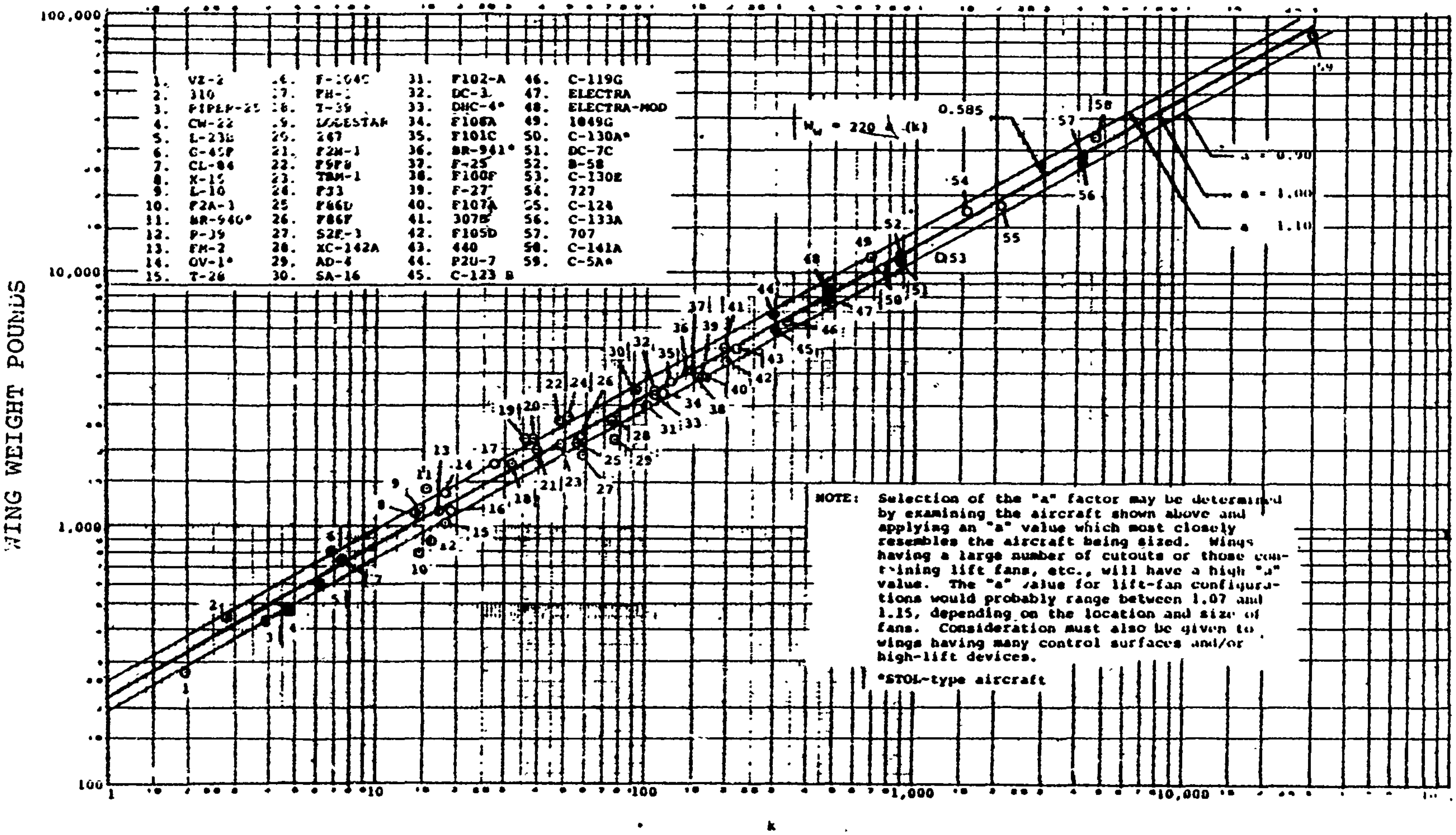


Figure 4-32. Wing Weight Trend.

to be in the wing. The following equation may be used to determine the value of k_{WF}:

$$k_{WF} = \frac{\text{Estimated wing fuel}}{(S_W)^{1.5}} .$$

It should be noted that the program will never permit the fuel carried in the wing to be greater than the total fuel available and therefore, if it is desired to carry all the fuel in the wing, the user should simply input a large value for k_{WF}.

Aircraft designed specifically for STOL operation (running takeoff and landing over a 50-foot obstacle within 500 to 2,500 feet) normally require a large number of high-lift devices on the wing. The weight penalty associated with the high-lift devices will vary with the aircraft's performance goals, load factor, speed, and surface area of the lift device being employed. To aid in selecting k_{WW} for a STOL configuration, refer to Figure 4-32. This illustration includes and identifies a number of STOL aircraft. Selection of k_{WW} should be based on the Figure 4-32 aircraft which most closely compares to the configuration being analyzed. If the wing being analyzed is not similar to one of those on Figure 4-32, the following alternate method can be used: a) Input k_{WW} = 200 into location 0426 on the weight input sheets; b) calculate a high lift factor to account for the type of high lift system being used. The high lift factor (HLF), calculated from the following equation, should be input to location 0433 (wing multiplicative factor) on the weight input sheet.

$$HLF = 1 + \frac{S_{HLS}}{S_W} \ (TF)$$

where HLF = high-lift factor
S_W = planform area of wing taken from ℄ of aircraft, square feet
S_{HLS} = retracted planform area of high-lift surface, square feet
TF = high-lift type factor from Table 4-9

The HLF must be placed in location 0433 (wing multiplicative factor) on the weight input sheet.

Figure 4-32 presents the weights of conventional wings designed primarily by airloads resulting from forward flight. The term $R_M W_X$ in the trend equation indicates the magnitude of the resultant wing shear and bending loads located at the semispan center of lift in forward flight. In tilt-rotor-type aircraft where the propulsion and dynamic components (engine and prop/rotor installations, drive system, nacelle, etc.) are located at the wingtips, the wing design requirements result from

TABLE 4-9
HIGH-LIFT FACTORS -
WING CONTROL SURFACES

Lift Device and Hinge	Type Factor (TF)
Simple flap	0.0
Standard or simple Fowler	0.585
Fowler with variable droop (track + hinge)	0.741
Fixed double slot, simple hinge	0.585
Fixed double slot, extended hinge	0.741
Double slot, 2 simple hinges	0.741
Double slot, track + simple hinge	1.000
Triple slot, track + 2 simple hinges	1.270
Triple slot, 2 tracks + simple hinge	1.460
Slat (with simple track)	0.585
Slat with track	0.810
Droop LE, simple hinge	0.490
Spoiler-brake comb., simple hinge	0.390
Krueger, simple hinge	0.490
Krueger, extended hinge (707 type)	0.666
Blown flap-hot, single slot, simple hinge	0.666

For aircraft employing combinations of the above devices, the appropriate type factors should be summed.

vertical flight and transitional modes and the term $R_M W_X$ is interpreted by locating the center of lift at the thrust line of the rotor and W_X is redefined as the aircraft gross weight less the weight of the nacelle and contents. The computer subroutine does not relocate the center of thrust for tilt rotor type aircraft. This must be analyzed separately and the wing K adjusted accordingly.

Tails

The weights of the horizontal and vertical tails are determined from the weight trend equations presented below.

Horizontal Tail

$$W_{HT} = 350(k)^{0.54}, \text{ where}$$

$$k = \left[F_H\right]\left[\frac{S_H}{10^2}\right]\left[\frac{\log V_D}{TMA \times t}\right] \text{ and } F_H = \left[\frac{W_G}{10^4}\right]\left[\frac{ky}{10}\right]\left[\frac{b_H}{10}\right]\left[\frac{1+2\lambda H}{1+\lambda H}\right]\left[k_{TL}\right] .$$

Vertical Tail

$$W_{VT} = 360(k)^{0.54}, \text{ where}$$

$$k = \left[F_V + \frac{a\ F_H}{2\ b_V}\right]\left[\frac{S_V}{10^2}\right]\left[\frac{\log V_D}{TMA \times t}\right] \text{ and } F_V = \left[\frac{W_G}{10^4}\right]\left[\frac{k_z}{10}\right]\left[\frac{b_V}{10}\right]\left[\frac{1+2\lambda v}{1+\lambda v}\right] .$$

Legend

W_G = design gross weight, pounds
k_y = pitch radius of gyration, feet
k_z = yaw radius of gyration, feet
b = tailspan, feet
λ = taper ratio, $\frac{\text{(chord at tip)}}{\text{(chord at root)}}$

S = planform area, square feet
F = tail load parameter
V_D = dive velocity, knots
TMA = tail moment arm (measured from wing 1/4 chord to tail 1/4 chord), feet
t = root thickness, feet
a = height of horizontal tail attachment to vertical tail (measured from root of vertical tail), feet
H = subscript H denotes horizontal tail
v = subscript v denotes vertical tail
k_{TL} = tail load factor

The trends consider the tail loads which are a function of the gross weight, span, radius of gyration, and point of load application (distance of the mean aerodynamic chord from the

point of support). The "a" term in the vertical tail equation accounts for T-tail configurations. Figures 4-33 and 4-34 present the aircraft used to develop the trends. Refer to Figures 4-35 and 4-36 to determine the values of k_y and k_z to be placed in the structural box of the weight input sheet.

The term k_{t1} in the structural box of the weight input sheet is nominally 1. It is included to provide a means for penalizing the weight of the horizontal tail when loads incurred from carrier deck landings become a design consideration. The value of K_{t1} under these conditions would vary between 1.1 and 1.2 depending on the magnitude of the design loads.

Body Group

The weight of the body structure is determined from the following equation:

$$W_{BG} = 124a(k)^{.508}, \text{ where}$$

$$k = \left[\frac{W_x}{10^4}\right]^{0.7} \left[\frac{Sf}{10^3}\right] B(Lf + L_{RW})^{0.5} \left[Log_{10}\ V_D\right] (\Delta P + 1)^{0.2}\ (N)^{0.3}$$

Legend

- W_{BG} = weight of body group, pounds
- W_x = weight of fuselage and contents (includes empennage), pounds
- Sf = wetted area of fuselage, square feet
- B = maximum fuselage width, feet
- Lf = length of fuselage, feet
- L_{RW} = length of ramp well, feet
- L_{EB} = length of engine bay (in lieu of or added to L_{RW}, depending on configuration), feet
- V_D = dive velocity, knots
- ΔP = limit differential cabin pressure, pounds per square inch
- N = ultimate load factor
- "a" = body adjustment factor

Figure 4-37 indicates the relative body weight variation between different families of aircraft. Commercial, military, cargo, carrier-based, and land-based aircraft represent the different families. Other factors which affect the weight of the fuselage include such things as number of cutouts, type of entrance doors and stairs, ramp design, pressurized versus unpressurized, etc.

A mean line of 124 has been selected as an average for all the aircraft shown in Figure 4-37. The body adjustment factor "a" corrects the 124 constant in accordance with the family being

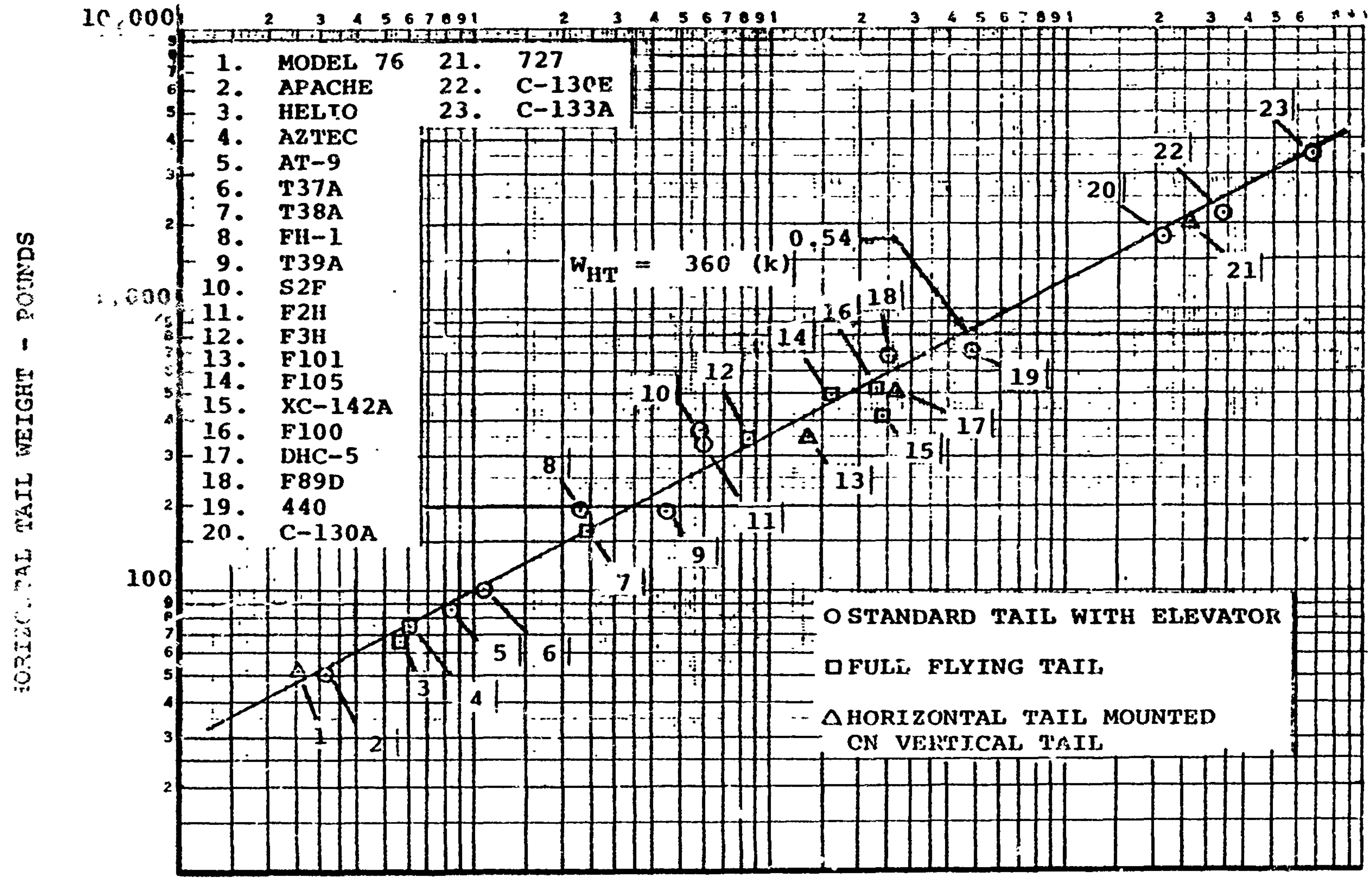


Figure 4-33. Horizontal Tail Weight Trend

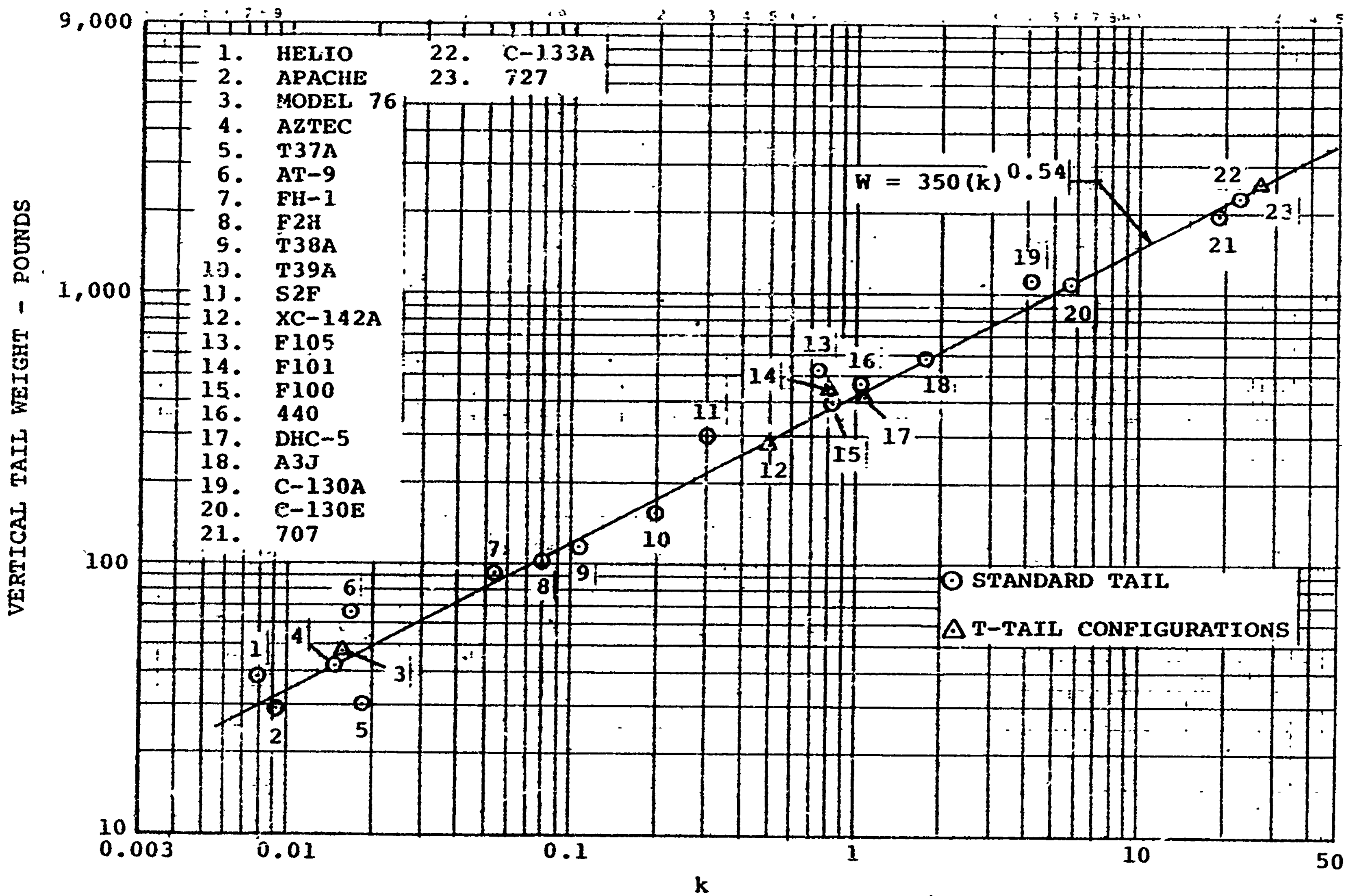


Figure 4-34 . Vertical Tail Weight Trend.

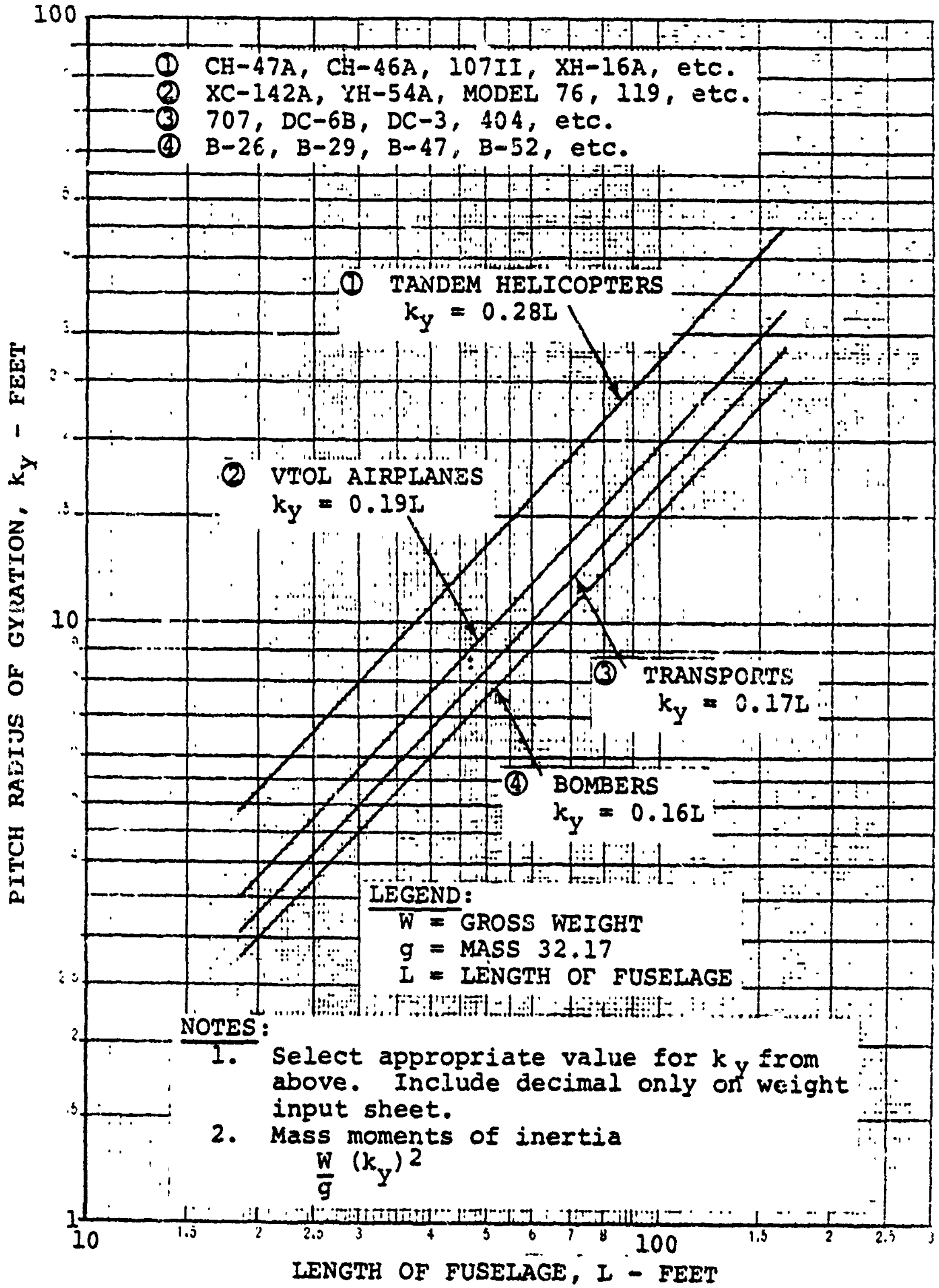
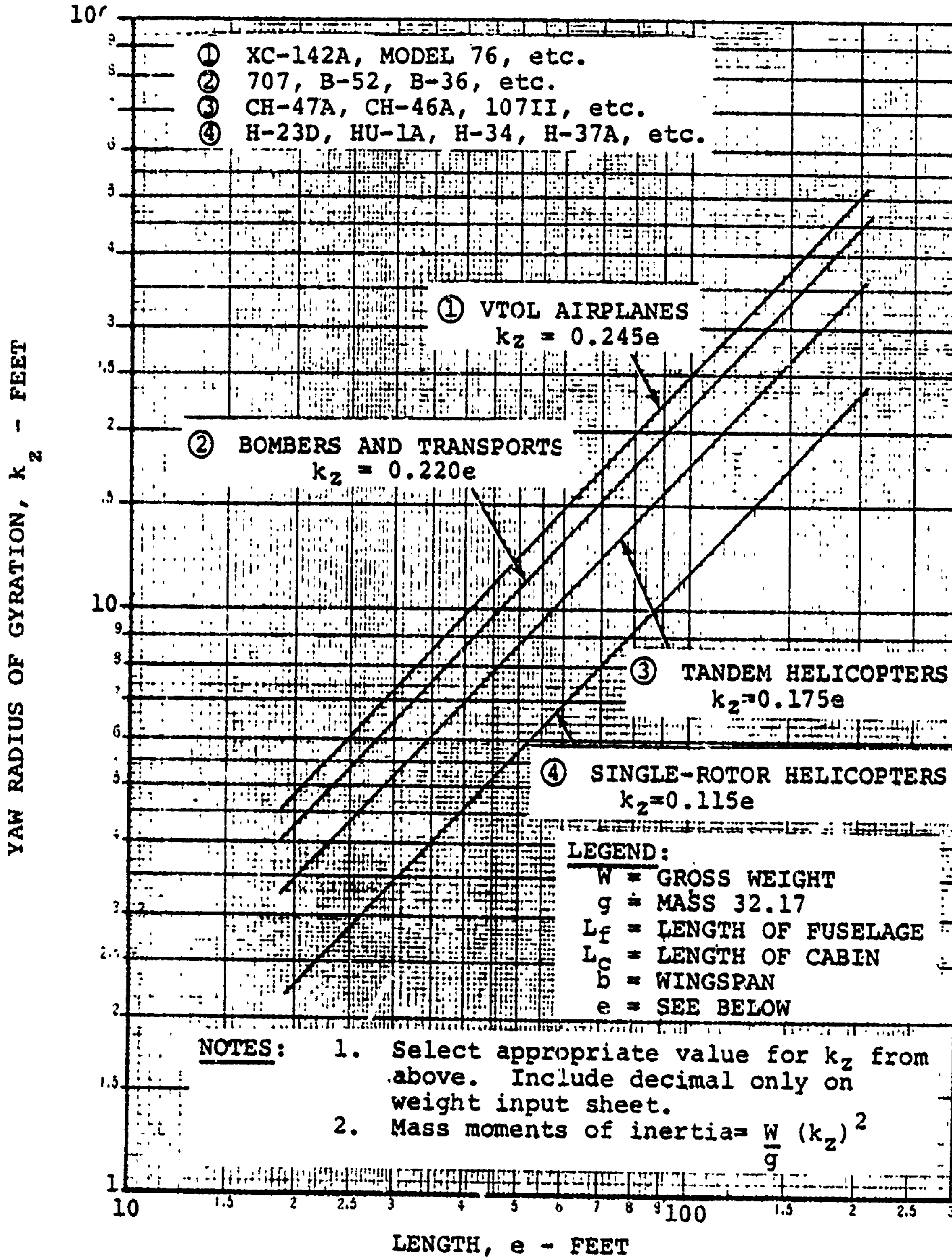


Figure 4-35. Radius of Gyration Trend - Pitch.



$e = \frac{b + L_f}{2}$ (AIRPLANES) $e = L_f + L_c$ (HELICOPTERS)

Figure 4-36. Radius of Gyration Trend - Yaw.

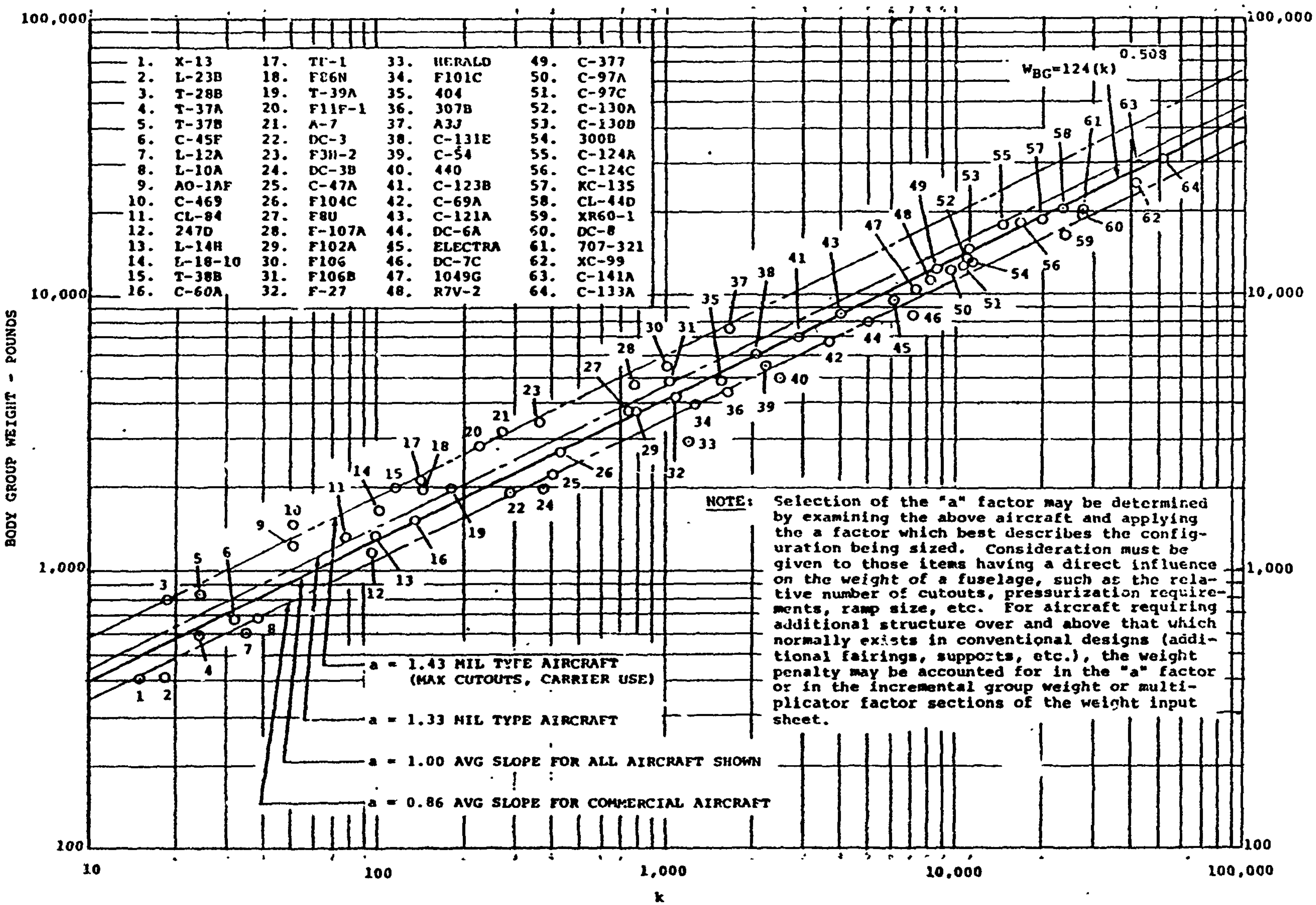


Figure 4-37. Body Group Weight Trend.

configured. For aircraft having engines, gas generators, fans, etc., on top of the fuselage, an additional penalty must be added to the 124 "a" constant to account for the additional supports, fairings, etc., required to support and enclose these components. Refer to Figure 4-37 to determine the "a" factor which best describes the configuration. The revised constant, 124 "a", is the k_B term to be inserted in the appropriate box of the weight input sheet. The limit differential cabin pressure (ΔP) must also be placed in the proper location in the incremental block of the weight input sheet.

Alighting Gear

For the normal tricycle gear geometry, the total landing gear weight including the running gear (wheels, tires, brakes, etc.), structure (shock struts, drag struts, support structure, etc.), and controls (retraction, steering, systems, etc.) is expressed as a percentage of the design gross weight where:

$$W_{LG} = (k_{LG})\ W_g$$

where W_{LG} = total weight of the landing gear

$k_{LG} = \dfrac{\text{landing gear}}{\text{gross weight}}$

W_g = design gross weight

The percentage will vary between 0.015 and 0.080 depending on the complexity and design loads of the system. Conventional landing gear with retracting systems, operating on improved runways, normally run between 0.025 and 0.037. STOL-type systems operating on rough runways require longer and larger alighting gear components to accommodate the aircraft's higher rotational angle and sink speeds required to operate at the shorter field lengths. k_{LG} for the STOL aircraft will normally vary between 0.035 and 0.08. The main gear usually weighs about 80 percent of the total gear weight. The k term in the weight expression above is the value that must be placed in the k_{LG} box of the weight input sheet. The weight of the main gear is included by placing 0.80 in the k_{MG} location on the weight input sheet.

Table4-10 is included as a guide in selecting k_{LG}. It includes the total gear weight as a percentage of the gross weight for a sampling of military, commercial, and VTOL aircraft.

Flight Controls

The weight of the flight controls will vary depending on the type of control system required (manual, power boost, etc.) and the type of aircraft being considered (tilt-wing,

TABLE 4-10
LANDING GEAR WEIGHTS

Aircraft	Gross Weight (lb)	Total Gear Weight (lb)	Percent of Gross Weight
Military			
DHC-4*	28,500	1,398	0.049
F-27	42,000	1,884	0.045
Breguet 941*	46,000	2,626	0.057
DHC-5*	41,000	1,800	0.044
C-123B	54,000	2,331	0.043
C-118	107,000	3,895	0.036
C-130B*	135,000	4,824	0.036
C-130E*	155,000	4,939	0.032
C-124C	185,000	11,700	0.063
C-133A	275,000	10,635	0.039
C-141	318,000	10,357	0.033
C-5A	732,000	32,711	0.045
Commercial			
Gulfstream	35,100	1,237	0.035
Convair 440	49,100	2,158	0.044
Boeing 737-100	102,000	4,372	0.043
Boeing 727-100	161,000	7,211	0.044
Convair 880	184,500	6,933	0.038
Boeing 707-320	336,000	12,982	0.038
VTOL			
XV-5A	12,500	482	0.038
XV-4B	12,500	389	0.031
CL-84	12,600	369	0.029
X-22A	15,980	449	0.028
XC-142A	37,500	1,266	0.034

*STOL-type aircraft

tilt-rotor, fixed-wing, etc.). Aircraft control systems requiring power boost and those having high-lift devices and many control surfaces will normally weigh more than those having a manual system and few control surfaces. Consideration must be given to these factors when determining the flight control constants to insert on the weight input sheet.

An equation defining the weight of the flight controls of a tilt-wing configuration is used as a base for the controls of all aircraft since it includes factors which can be isolated and applied to other types of configurations. Values for the various k factors listed below must be inserted in the flight control blocks of the weight input sheet. A description of the items comprising each of the control subgroups is included along with a sample of the k input values. Refer to the referenced trend curves, included for each of the major control groups, as an aid in selecting the respective k values.

<u>Tilt-Wing</u>

$$W_{FC} = k_{CC}\left(\frac{W_G}{1000}\right)^{0.41} + k_{UC}\, W_{R_{TOTAL}} + k_H\left(\frac{W_{R_{TOTAL}}}{100}\right)^{0.84} + k_{FW}\, W_g + k_{SAS} + k_{TM}\, W_g$$

<u>Legend</u>

k_{CC} = constant for cockpit controls = 26

Cyclic and collective control sticks and linkages, pedals, cables and rods (Figure 4-38).

k_{UC} = constant for upper controls = 0.30

All components from and including the power actuators up through the pitch links. Major items included are the actuators, swashplate, and pitch links (Figure 4-39).

k_H = constant for systems and hydraulics = 40

All components between the cockpit controls and the rotor controls including actuators, artificial feel system, mechanical programmer, bell-cranks, rods, idlers, etc.

Main hydraulic systems including pumps, reservoirs, accumulators, filters, valves, lines, fluid, and supports (Figure 4-40).

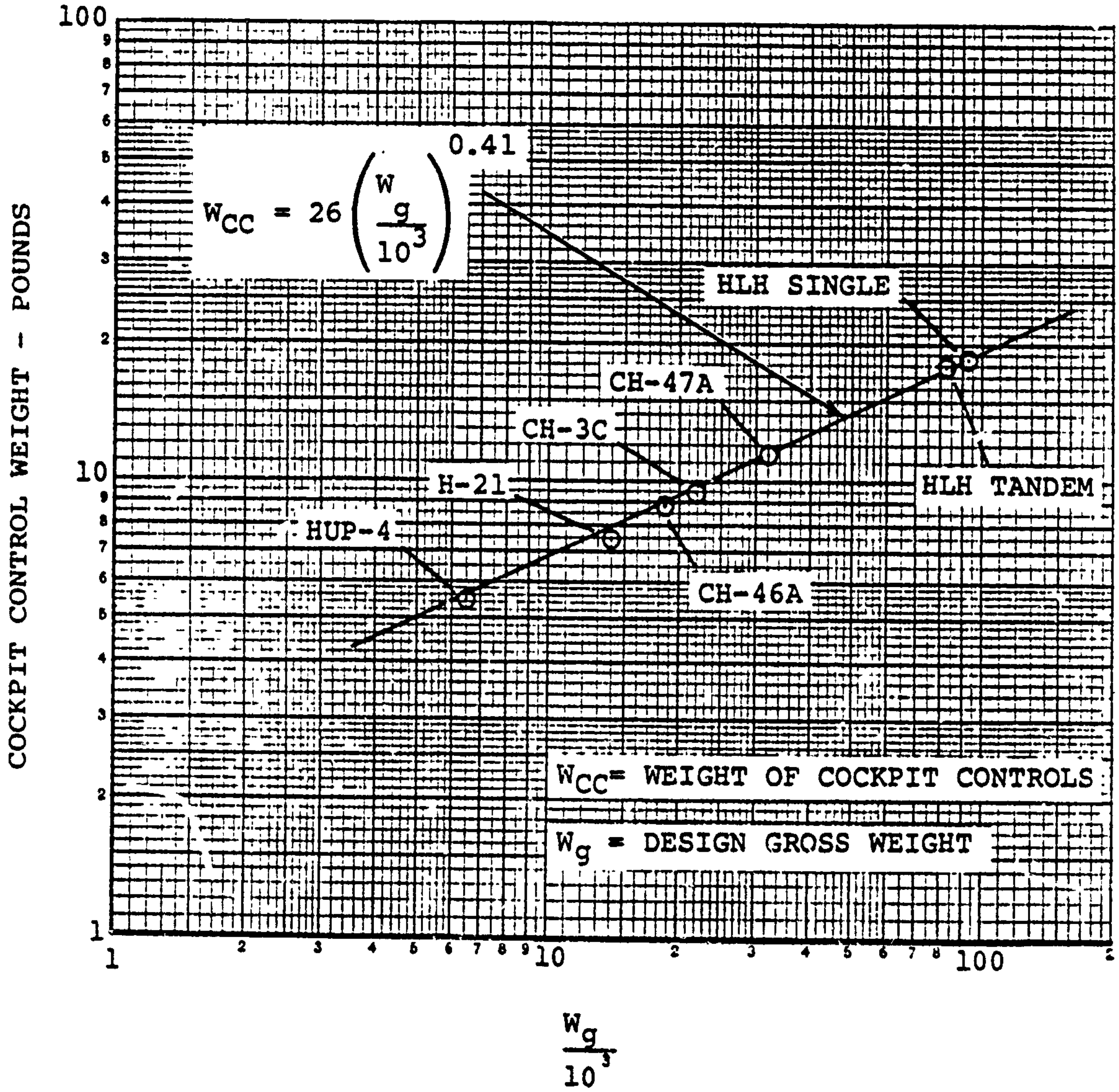


Figure 4-38. Cockpit Controls Weight Trend.

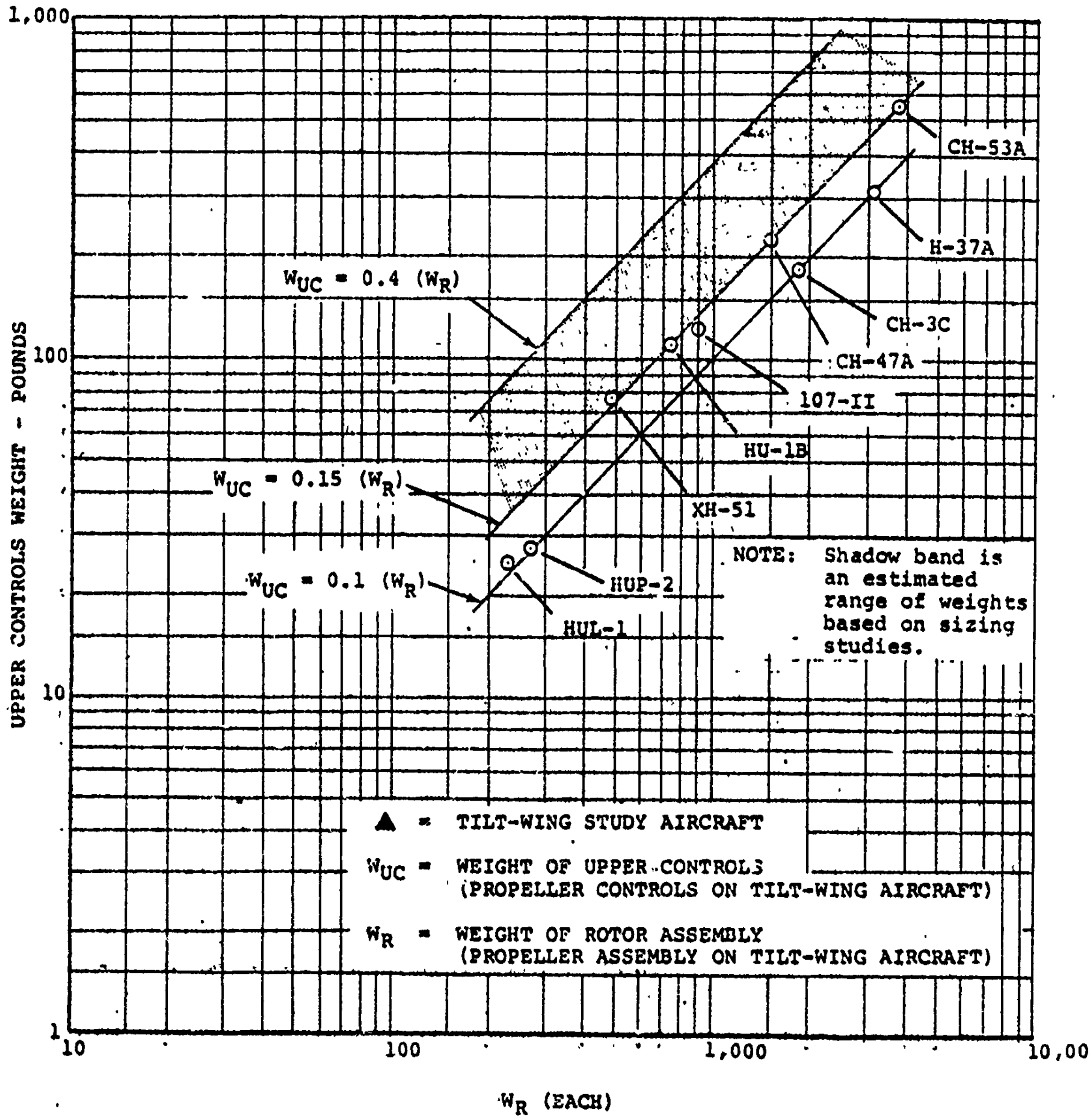


Figure 4-39. Upper Controls Weight Trend.

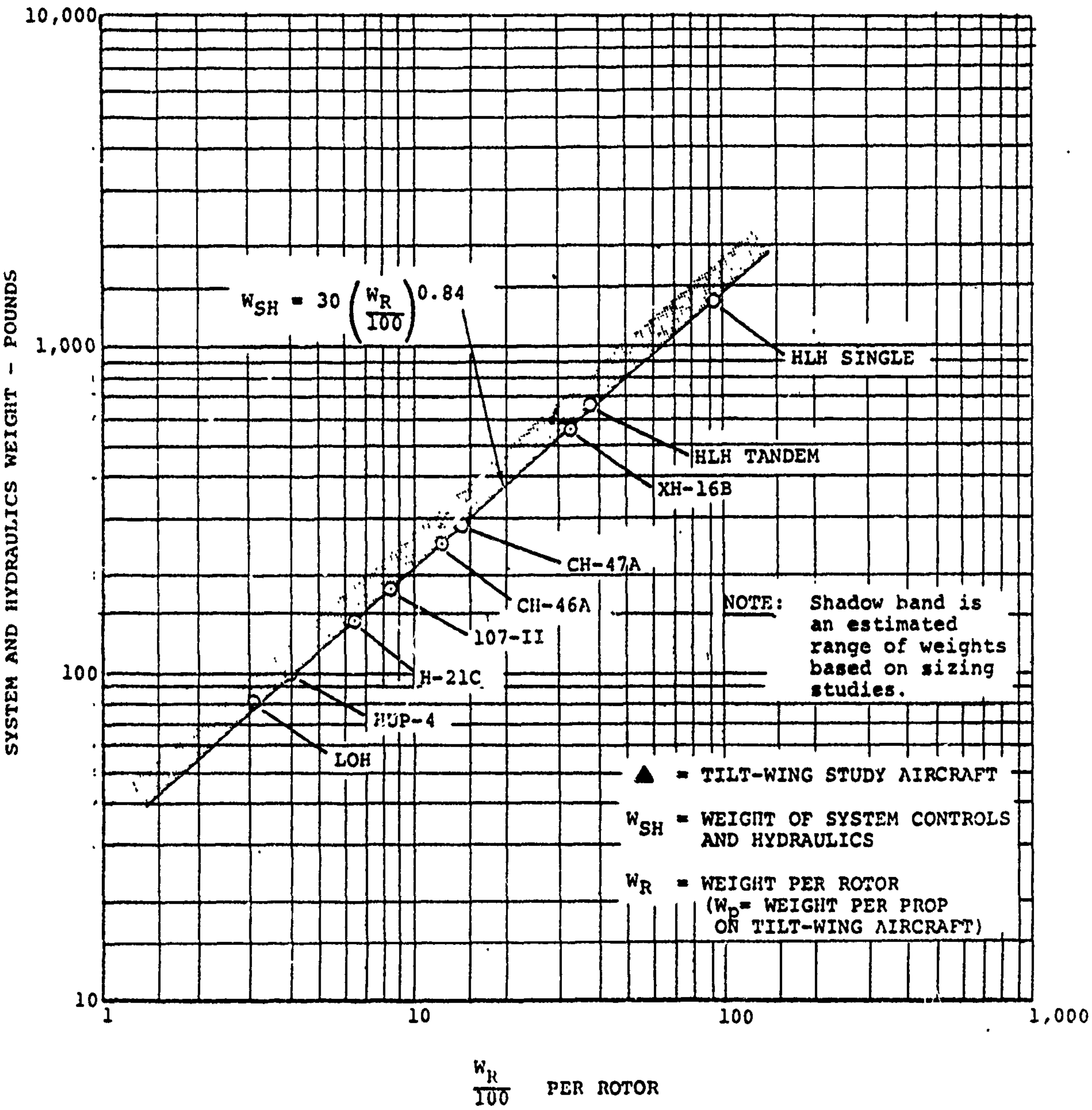


Figure 4-40. System and Hydraulics Weight Trend.

k_{FW} = constant for conventional fixed-wing controls = 0.015

All components, actuators, and supports associated with moving the control surfaces - LE umbrellas, flaperons, spoilers, and tail surfaces, (including variable-incidence horizontal stabilizer), excluding those items common to the system quoted above. The constant for STOL aircraft employing a large number of high-lift devices will vary between 0.02 and 0.04 depending on the size and complexity of the surface (Table 4-11).

k_{SAS} = constant for stability-augmented system and mixing units = 175

Includes black boxes and mechanical mixing units.

k_{TM} = constant for tilting mechanism = 0.005

All components and supports required to tilt the wing or nacelle including actuators, power control units, mechanical system, fittings, and hardware (Figure 4-41).

Fixed-Wing

When sizing propeller-driven fixed-wing aircraft, use k_{UC} and k_{FW} only.

For aircraft requiring tailfans or rotors for pitch and/or yaw control, delta weight must be added in the incremental group block of the weight input sheet, ΔW_{FC}. Other factors may be taken from the tilt-wing equation as before. An estimate of the weight of the fans or rotors may be made by using the rotor group and drive system trends described on pages 4-144 and 4-168 and adding an additional allowance for the weight of the structure, cross-shaft, and controls necessary to complete the installation. Aircraft requiring reaction controls must also be accounted for in the ΔW_{FC} of the incremental block. No attempt is made to describe the weight of these controls since their weight will depend on the type (puff-pipes, compressors, turbines, etc.) and the amount of control power and response rate necessary to meet specified requirements.

Engines, Gas Generators, and Fans

The weight of the lift engines, cruise engines, gas generators, and lift fans is determined as part of the engine sizing routine considered elsewhere in the program. There is no provision for determining their weights on the weight input sheet. The ΔW_p and k_5 blocks of the input sheet provide a method for adding weight to the engines, etc., if desired. The weights

TABLE 4-11
FLIGHT CONTROL SURFACE
ACTUATION SYSTEMS DATA

Aircraft	(1) Flight Design Weight (lb)	(2) Flight Control Weight* (lb)	(2) ÷ (1)**	Control Surfaces: Ailerons	LE Flaps or Slats	TE Flaps	Elevator or UHT	Rudder	Spoiler or Deflector
OV-1D	15,421	552	0.035	M	-	M	M	M	H
DHC-4	28,500	467	0.016	M	-	M	M	M	-
DHC-5	41,000	610	0.015	M	-	M	M	M	-
Breguet 941	46,000	1,056	0.023	H/M	-	H	H/M	H/M	-
F-28	50,000	1,009	0.020	H	-	H	H	H	-
C-123B	54,000	599	0.011	M	-	H	M	M	-
737-200	100,000	2,182	0.022	H/M	H/E	H/E	H/M	H	H
B-47B	125,000	2,047	0.016	H/M	H	H/E	H/M	M	-
C-130B	135,000	1,645	0.012	H	H	H	H	H	-
727-100	161,000	2,996	0.019	H/E	H/E	H/E	H/M	H	H
C-124C	185,000	1,493	0.008	H/M	-	H	M	M	-
720-022	203,000	2,199	0.011	M	H	H/E	M	H/M	H
C-133A	275,000	1,804	0.009	M	-	H	M	M	-
C-5A	728,000	6,543	0.009	H	H	H	H	H	H

*Reported flight control weight
**This figure to be placed in location 0405 on weight input sheet

M = mechanically operated
H = hydraulically operated
E = electrically operated

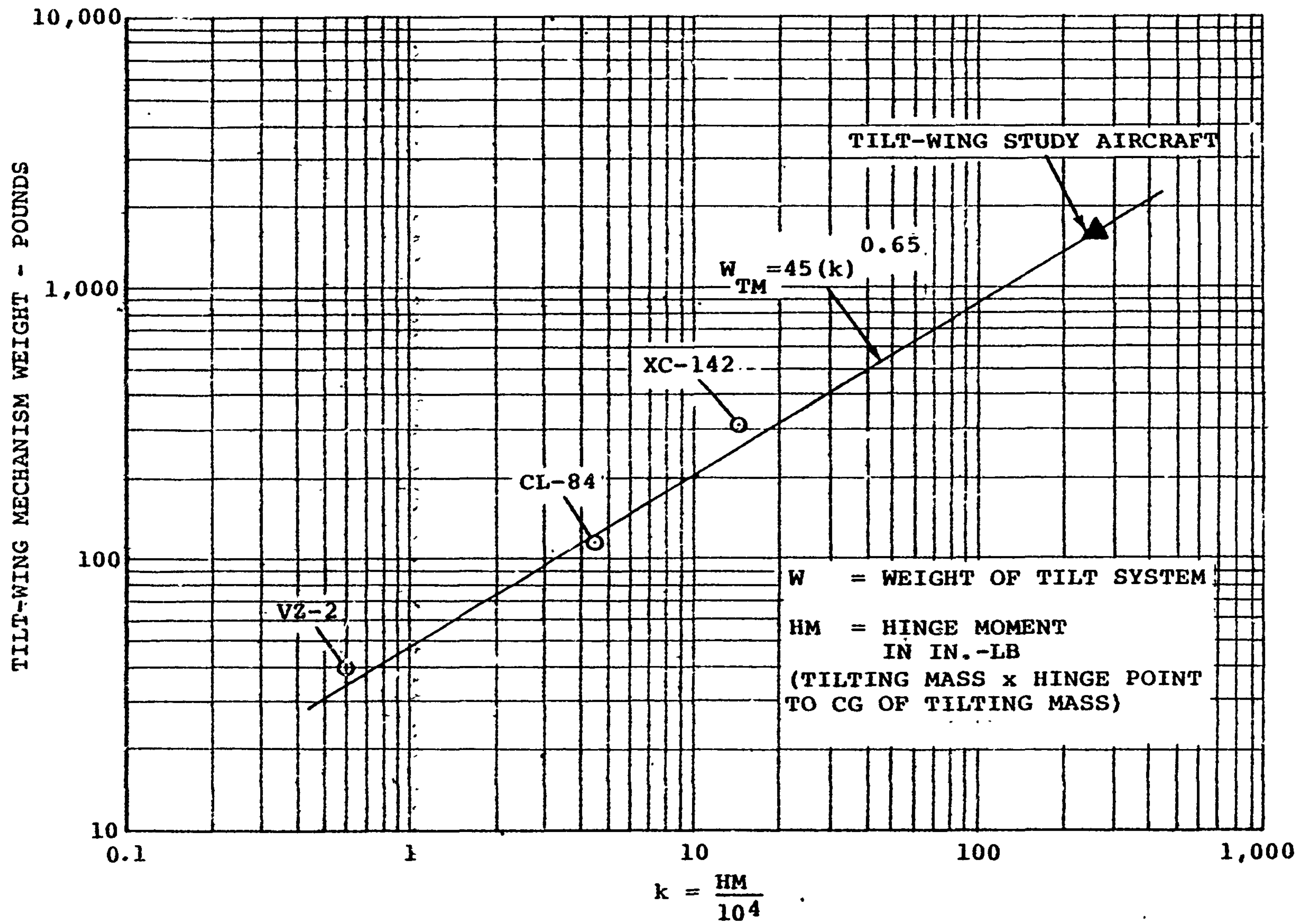


Figure 4-41. Tilt-Wing Mechanism Weight Trend.

of the ducting and other items associated with lift-fan aircraft are considered in the lift engine section and lift engine installation (k_{ES} and k_{LEI}) blocks of the weight input sheet.

Engine Section and Engine Installation

The engine section and engine installation weights are determined from the dry weight of the engines. The engine section weight is part of the weight empty and appears as item 10 in Table 4-7. It is basically the engine mounts, nacelle structure, firewall, and support pylons or struts. The engine installation weight is also part of weight empty and includes items 14, 15, 16, 17 and 19 in Table 4-6.

The weights of these two groups will vary greatly between aircraft depending on the type and powerplant arrangement of the configuration being sized. No attempt is made here to describe all the various approaches that may be used or to evaluate their weights, but instead a simple method of taking a percentage of the weight of the dry engines and/or fans, generators, etc., is used to define the weight of the engine section and its installation. The percentages applied will depend on the judgment of the user.

Examples of some typical values are presented in Table 4-12 and described as k_{PES} and k_{PEI} for the primary engines, and k_{LES} and k_{LEI} for the lift engines on the weight input sheet. The weights of thrust reversers, deflectors, and/or sound suppression systems are not included in the k factors and, if required, must be added to the multiplicative factor section of the weight input sheet. (K_4 for lift engines and K_5 for primary engines - see Table 4-12.)

A secondary method is included for determining the weight of the engine section. Equations are presented for the mounts, nacelle, and firewall. Pylons or strut weights are not included; these must be estimated and added separately and their weights included in the Δ structure box. k_{MT}, k_{NAC}, and ℓ_{MT} can be determined from the data given below and inserted in the proper location on the weight input sheet.

The weight of the engine section using the secondary method is determined from the following equations:

$$W_{MT} = \frac{W_p}{10^3}\,(2 + \ell_m \ell_n)\,n k_{mt}$$

$$W_{NAC} = \frac{1}{2}\,(\mathrm{Log}_{10}\, V_D k_s S_N k_{NAC})$$

$$W_{FW} = \overline{D}^2\, N_{PE}$$

TABLE 4-12
ENGINE SECTION AND
INSTALLATION FACTORS

Turbofan	Turbojet	Turboprop Turbojet	Lift Jet	Lift Fan
See Note 1 k_{PES} = 0.40 k_{PEI} = 0.14	k_{PES} = 0.33 k_{PEI} = 0.14	k_{PES} = 0.45 k_{PEI} = 0.14	k_{LES} = 0.70* k_{LEI} = 0.30* *For pod-mounted engines	k_{LES} = 0.35 k_{LEI} = 0.25
See Note 2 K_5 = 1.15 (Primary engine thrust reverser)	K_5 = 1.10 (Primary engine thrust reverser) K_5 = 1.03 (Primary engine sound suppression)	K_5 = 1.15 (Primary engine thrust reverser) K_5 = 1.03 (Primary engine sound suppression)	K_4 = 1.25 (Lift engine thrust reverser) K_4 = 1.03 (Lift engine sound suppression)	

NOTES:

1. These values must be placed in their proper location in the flight control, structure, or propulsion sections of the weight input sheet.

2. If thrust reversers and/or sound suppression are required, these values must be placed in the multiplicative factor section of the weight input sheet. When both thrust reversers and sound suppression are required, add the individual values for each together and place the total in the proper box. Example: Turbojet requiring both thrust reversers and sound suppression - K_5 value would be 1.10 + 0.03 or 1.13.

3. All values represent a percentage of the dry engine or fan weights.

Legend

W_{MT} = weight of engine mounts, pounds
W_p = weight of propulsion group plus upper controls less fuel system, pounds
ℓ_m = distance from engine cg to closest structural attachment point between nacelle and wing, as a percentage of nacelle length
η = ultimate load factor
k_{mt} = nacelle type factor - from chart
V_D = dive velocity, knots
k_s = nacelle weight factor, from Figure 4-42
S_N = nacelle wetted area per aircraft, square feet
k_{NAC} = factor k_{mt} x k_{dr} from Table 4-13
W_{FW} = weight of firewall, pounds
$\bar{D}$ = average nacelle diameter or equivalent diameter, feet
N_{PE} = number of primary engines

Fuel System

The weight of the fuel system, defined as k_{fs} in the propulsion block of the weight input sheet, will vary depending on the capacity, type, and complexity of the system required. For commercial aircraft having simple fuel systems in the wing, the value for k_{fs} would range between 0.02 and 0.07; for aircraft requiring self-sealing tanks with more complex systems, the value would range between 0.10 and 0.15.

Drive System

The weight of the drive system including shafting, lubrication, etc., is derived from the following equation:

$$W_{DS} = 300\ a(k)^{0.8} \qquad \text{where} \quad k = \left[\frac{HP_{Total} \times 1.1}{RPM_{Rotor}}\right].$$

Legend

W_{DS} = weight of drive system, pounds
HP_{Total} = total aircraft horsepower
RPM_{Rotor} = rotor design rpm
"a" = drive system adjustment factor

The factor "a" is an adjustment factor used to account for the type, number of boxes, and special features, etc., included in the drive system. Figure 4-43 gives typical examples of the "a" factor. To determine the k_{DS} value to place on the weight input sheet, multiply the 300 constant by your selection of "a".

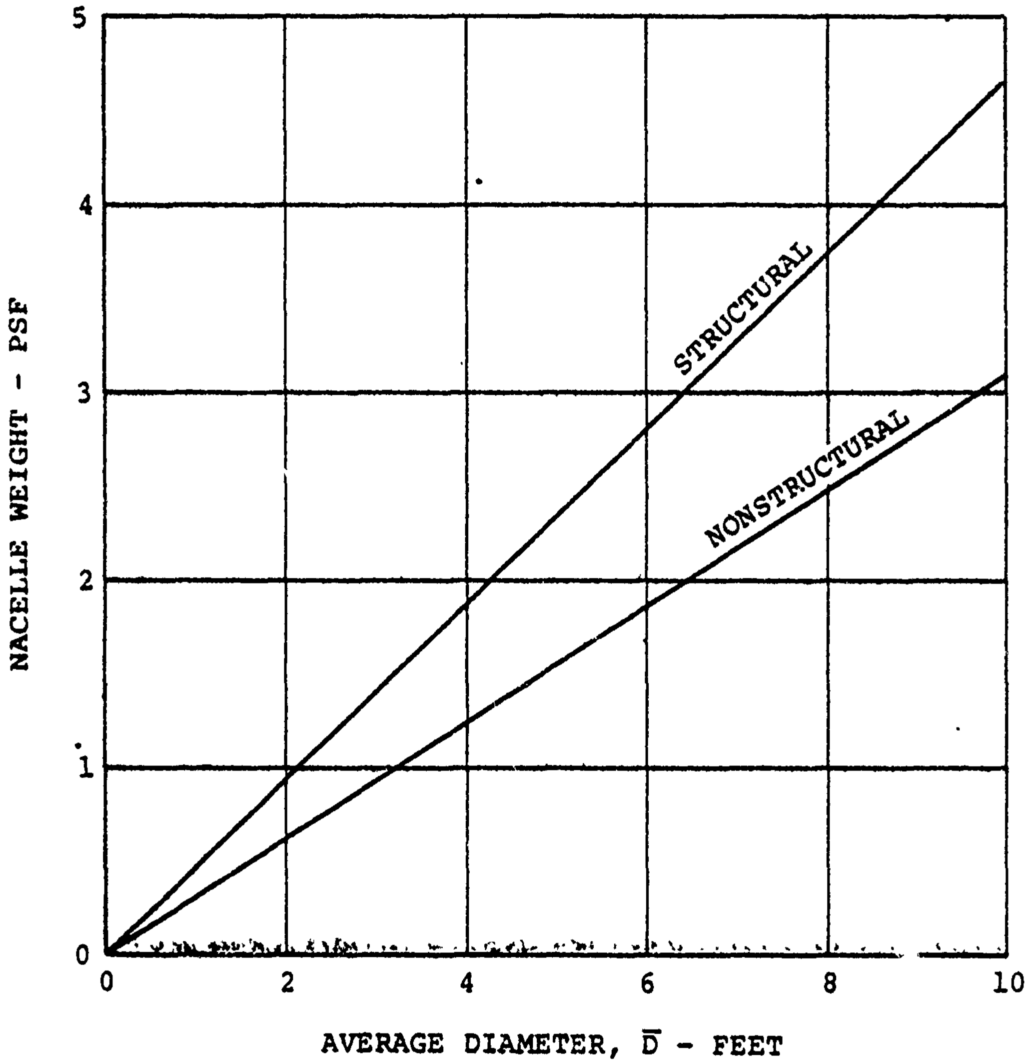


Figure 4-42. Engine Nacelle Weight Trend, k_s.

TABLE 4-13
ENGINE NACELLE FACTORS

Parameter	Factor
Type of Nacelle	k_{mt}
Through wing	0.9
Standard (including pylon type)	1.0
Fanjet $= 1 + \dfrac{\ell_f}{3 \times \ell_n}$	-
Structural nacelle $= 1 + \dfrac{\ell_s}{\ell_n}$	-
Type of Engine	k_{et}
Jet or fan	1.0
Turboprop	1.1
Piston (including vibration absorbers)	1.2
Doors, Cowl Flaps, and Work Platforms	k_{dr}
Minimum doors	0.8
Standard	1.0
Radial engine cowl flaps	1.1
Split and hinged engine cowl	1.2
Hinged cowl with work platform	1.3
- High wing	1.2
- Low wing	1.1
These factors should be assessed on basis of size of cowl versus total nacelle.	

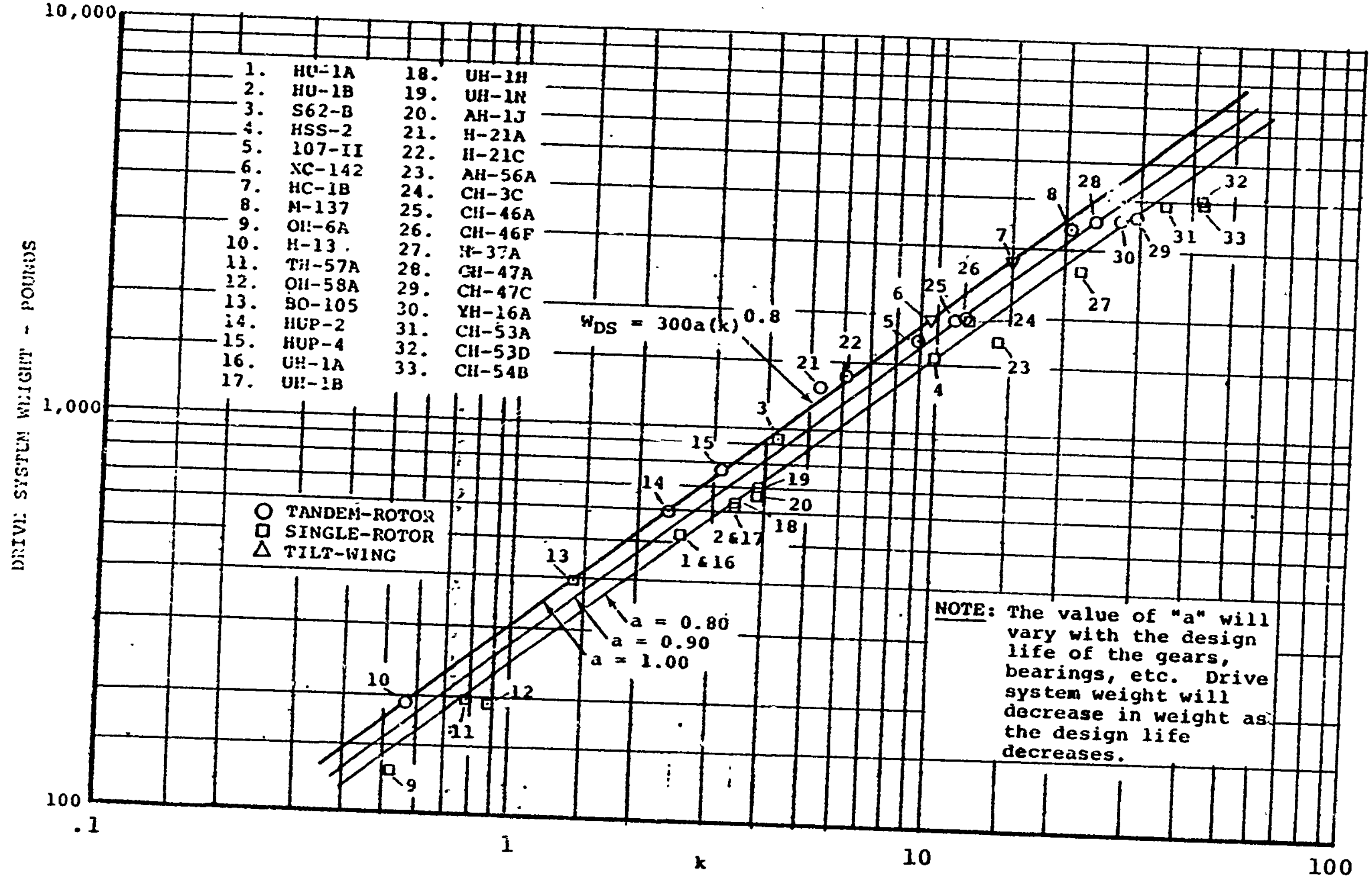


Figure 4-43. Drive System Weight Trend.

The k_{VT} term in the propulsion block of the weight input sheet is provided to allow for variations in the drive system weight when the hover tipspeed and transmission tipspeed or the maximum power and the transmission design power are not the same. The nominal value for k_{VT} is 1 when these parameters are similar. The value of k_{VT} will change accordingly when tip speed and power vary as indicated by the following expression:

$$\left[\frac{\text{Design tipspeed}}{\text{Hover tipspeed}}\right]\left[\frac{\text{Maximum power}}{\text{Design power}}\right].$$

Fixed Equipment

The weight of the fixed equipment is included in the weight empty and consists of the following groups: auxiliary powerplant, instruments and navigation, electrical, electronics, armament, furnishings and equipment, air conditioning and deicing, photographic, and auxiliary gear (see Table 4-7).

The weight of the fixed equipment will vary with the type and requirements of the aircraft under study. It will weigh more in passenger aircraft than it does in the cargo type; it will be heavier in propeller aircraft than it is in jet-powered aircraft; and in the pressurized aircraft of each type it will be heavier than those that are unpressurized. Table 4-14 gives some typical examples of the fixed-equipment weights for a military cargo aircraft and commercial passenger configurations. The cargo plane would be similar to a C-123; the passenger aircraft is similar to a Boeing 737 or a Douglas DC-9. An airbus version of the passenger aircraft is also included for comparison. The major difference in the airbus configuration is in the weight of the furnishings and equipment group, where passenger comfort level is the predominant factor.

The total weight of the fixed equipment, W_{FE}, must be placed in the W_{FE} block of the weight input sheet.

Fixed Useful Load

The weight of the fixed useful load represents a portion of the useful load and includes the crew, trapped liquids, engine oil, and other items that are required, except for fuel, which make the aircraft operational (refer to page 4-143). Typical weights for fixed-useful-load items are listed below. Graphs are included as a guide for determining the weights of the trapped liquids and engine oil. The total weight of the items below must be placed in the W_{FUL} block of the weight input sheet.

BOEING VERTOL COMPANY

WEIGHT SUMMARY - PRELIMINARY DESIGN
(MIL-STD-1374)

TABLE 4-14 FIXED EQUIPMENT WEIGHTS	Cargo Transport	Commercial Airliner 60 Passengers	Commercial Airbus 60 Passengers	
WING				
ROTOR				
TAIL				
SURFACES				
ROTOR				
BODY;				
BASIC				
SECONDARY				
ALIGHTING GEAR GROUP				
ENGINE SECTION				
PROPULSION GROUP				
ENGINE INST'L				
EXHAUST SYSTEM				
COOLING				
CONTROLS				
STARTING				
PROPELLER INST'L				
LUBRICATING				
FUEL				
DRIVE				
FLIGHT CONTROLS				
AUX. POWER PLANT	200	530	-	
INSTRUMENTS	350	675	650	
HYDR. & PNEUMATIC	275	450	392	
ELECTRICAL GROUP	1,000	2,000	1,600	
AVIONICS GROUP	750	750	750	
ARMAMENT GROUP				
FURN. & EQUIP. GROUP	1,600	5,120	3,054	
ACCOM. FOR PERSON.				
MISC. EQUIPMENT				
FURNISHINGS				
EMERG. EQUIPMENT				
AIR CONDITIONING	1,000	1,370	1,370	
ANTI-ICING GROUP				
LOAD AND HANDLING GP.				
FIXED EQPT WEIGHT	5,175	10,895	7,816	
CREW				
TRAPPED LIQUIDS				
ENGINE OIL				
FUEL				
GROSS WEIGHT				

REV.

FORM 26331 (2/73)

Military

- Crew (200 pounds per crewman)
- Unusable fuel and oil (see Figure 4-44)
- Engine oil (see Figure 4-45)

Commercial

- Crew and crew luggage (200 pounds per crewman)
- Stewardesses and luggage (140 pounds per stewardess)
- Unusable fuel and oil (see Figure 4-44)
- Engine oil (see Figure 4-45)
- Passenger service items (refer to page 4-80 for detailed list of items)

The weight of passenger service items depends on the passenger comfort level desired and the range of the mission. A tabulation of some typical values for various aircraft is shown below. The total weight of the passenger service items is the product of the number of passengers times the selection of the weight per passenger presented below.

Long-Range		Medium-Range		Short-Range	
Config	Wt/Pass.	Config	Wt/Pass.	Config	Wt/Pass.
707-121	37	880	28	727	18
707-321	36	720	25	BAC-111	14
VC-10	33	Electra	23	DC-9	12

Payload

The weight of the payload is determined by the mission requirements. The total weight of the payload must be put in the W_{PL} block of the weight input sheet.

Incremental Group Weights

The incremental group weights section of the weight input sheet is provided to enable the user to add fixed increments of weight where desired. Definitions and values for some of the items in this group have already been discussed. ΔW_{FC}, ΔW_P, and ΔW_{ST} represent incremental weights of the flight controls group, propulsion group, and structural group respectively. Any value inserted in the incremental group weight section

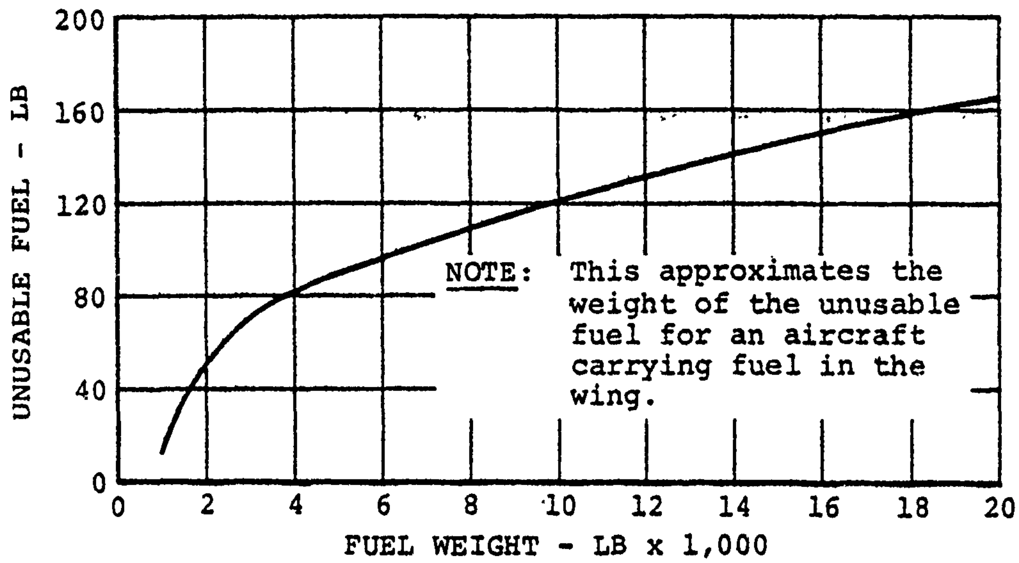


Figure 4-44 . Maximum Fuel Versus Unusable Fuel Weight Trend.

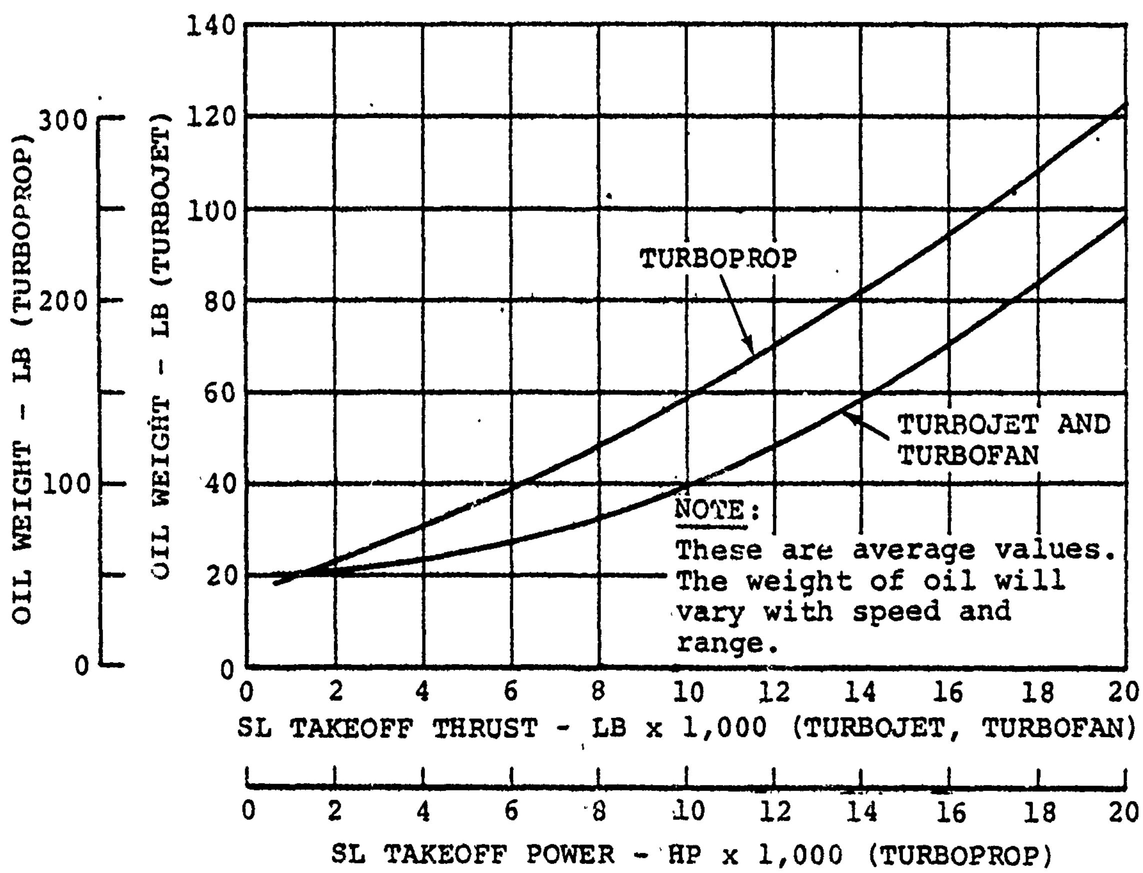


Figure 4-45. Engine Oil Weight Trend.

TABLE 4-15
MULTIPLICATIVE FACTORS

K	Location	Letter Code	Description
K_2	0459	$W_{R/P}$	Weight of rotors or propellers
K_3	0460	W_{DS}	Weight of drive system
K_4	0461	W_{EL}	Weight of lift engines
K_5	0462	W_{EP}	Weight of primary engines
K_6	0463	W_{LEI}	Weight of lift-engine installation
K_7	0464	W_{PEI}	Weight of primary engine installation
K_8	0433	W_W	Weight of wing
K_9	0434	W_{HT}	Weight of horizontal tail
K_{10}	0435	W_{VT}	Weight of vertical tail
K_{11}	0436	W_B	Weight of body
K_{12}	0437	W_{LG}	Weight of landing gear
K_{13}	0438	W_{LES}	Weight of lift-engine section
K_{14}	0439	W_{PES}	Weight of primary engine section
K_{15}	0410	W_{CC}	Weight of cockpit controls
K_{16}	0411	W_{UP}	Weight of upper controls
K_{17}	0412	W_H	Weight of hydraulics and vertical system
K_{18}	0413	W_{FW}	Weight of fixed-wing controls
K_{19}	0414	W_{SAS}	Weight of SAS and mixing unit
K_{20}	0415	W_{TM}	Weight of tilt mechanism
K_{21}	0465	W_{FS}	Weight of fuel system

remains constant regardless of gross weight. The nominal value for any block in this section is 0. All blocks must be filled in.

Group Weight Information

The nominal value for items in this section of the weight input sheet is 0. All blocks must be filled in. Definitions and constants for the various k factors have been previously discussed in the respective subgroup definitions.

Multiplicative Factors

The multiplicative factors described as K_8 thru K_{21} on the weight input sheet provide the capability of performing weight sensitivity studies. The factors are nominally 1. All blocks must be filled in. To vary the weight of any subgroup (K_{CC}, K_B, K_{DS}, etc.), insert the desired value in the appropriate box. Refer to Table 4-15 below to relate the various K factors with their respective groups. Inserting a value of 1.1 would increase the weight of the respective group by 10 percent, a value of 0.9 would decrease it by 10 percent, etc. The values in this group will vary with gross weight.

GROUP WEIGHT STATEMENT

AIRCRAFT

(INCLUDING ROTORCRAFT)

ESTIMATED - CALCULATED - ACTUAL

(Cross Out Those Not Applicable)

CONTRACT NO. ____________

AIRCRAFT, GOVERNMENT NO. ____________

AIRCRAFT, CONTRACTOR NO. ____________

MANUFACTURED BY ____________

		MAIN	AUX
ENGINE	MANUFACTURED BY		
	MODEL		
	NO.		
	TYPE		

PAGES REMOVED	PAGE NO.

MIL-STD-1374 PART I

GROUP WEIGHT STATEMENT
WEIGHT EMPTY

Page ____________
Model ____________
Report ____________

Name ____________
Date ____________

1	WING GROUP						
2	BASIC STRUCTURE - CENTER SECTION						
3	- INTERMEDIATE PANEL						
4	- OUTER PANEL						
5	- GLOVE						
6	SECONDARY STRUCTURE (Incl. Wing Fold Weight Lbs.)						
7	AILERONS (Incl. Balance Weight Lbs.)						
8	FLAPS - TRAILING EDGE						
9	- LEADING EDGE						
10	SLATS						
11	SPOILERS						
12							
13							
14	ROTOR GROUP						
15	BLADE ASSEMBLY						
16	HUB & HINGE (Incl. Blade Fold Weight Lbs.)						
17							
18							
19	TAIL GROUP						
20	BASIC & SECONDARY STRUCT. - STABILIZER						
21	- FIN (Incl. Dorsal)						
22	VENTRAL						
23	ELEVATOR (Incl. Balance Weight Lbs.)						
24	RUDDERS (Incl. Balance Weight Lbs.)						
25	TAIL ROTOR - BLADES						
26	- HUB & HINGE						
27							
28	BODY GROUP						
29	BASIC STRUCTURE - FUSELAGE or HULL						
30	- BOOMS						
31	SECONDARY STRUCTURE - FUSELAGE or HULL						
32	- BOOMS						
33	- SPEEDBRAKES						
34	- DOORS, RAMPS, PANELS, & MISC.						
35							
36							
37	ALIGHTING GEAR GROUP (Type:)						
38	LOCATION	Running Gear*	Arrest Gear*	Structure	Controls		
39							
40							
41							
42							
43							
44							
45	ENGINE SECTION or NACELLE GROUP						
46	BODY - INTERNAL						
47	- EXTERNAL						
48	WING - INBOARD						
49	- OUTBOARD						
50							
51							
52	AIR INDUCTION SYSTEM						
53	DOORS, PANELS, & MISC.						
54							
55							
56							
57	TOTAL STRUCTURE (To Be Brought Forward)						

*Change to Floats & Struts for Water Type Gear

GROUP WEIGHT STATEMENT
WEIGHT EMPTY

MIL-STD-1374 PART I

Page ____________

Name ____________ Model ____________

Date ____________ Report ____________

1	PROPULSION GROUP	Auxiliary	Main
2	ENGINE INSTALLATION		
3			
4	ACCESSORY GEAR BOXES & DRIVE		
5			
6	EXHAUST SYSTEM		
7	ENGINE COOLING		
8	WATER INJECTION		
9	ENGINE CONTROL		
10	STARTING SYSTEM		
11	PROPELLER INSTALLATION		
12	SMOKE ABATEMENT		
13	LUBRICATING SYSTEM		
14	FUEL SYSTEM		
15	TANKS - PROTECTED		
16	- UNPROTECTED		
17	PLUMBING, etc		
18	DRIVE SYSTEM		
19	GEAR BOXES, LUB SY & ROTOR BRK		
20	TRANSMISSION DRIVE		
21	ROTOR SHAFTS		
22	JET DRIVE		
23			
24	FLIGHT CONTROLS GROUP		
25	COCKPIT CONTROLS (Autopilot Lbs.)		
26	SYSTEMS CONTROLS		
27			
28			
29	AUXILIARY POWER PLANT GROUP		
30	INSTRUMENTS GROUP		
31	HYDRAULIC & PNEUMATIC GROUP		
32			
33	ELECTRICAL GROUP		
34			
35	AVIONICS GROUP		
36	EQUIPMENT		
37	INSTALLATION		
38			
39	ARMAMENT GROUP (Incl. Passive Prot. Lbs.)		
40	FURNISHINGS & EQUIPMENT GROUP		
41	ACCOMMODATION FOR PERSONNEL		
42	MISCELLANEOUS EQUIPMENT		
43	FURNISHINGS		
44	EMERGENCY EQUIPMENT		
45			
46	AIR CONDITIONING GROUP		
47	ANTI - ICING GROUP		
48			
49	PHOTOGRAPHIC GROUP		
50			
51	LOAD & HANDLING GROUP		
52	AIRCRAFT HANDLING		
53	LOAD HANDLING		
54			
55	MANUFACTURING VARIATION		
56	TOTAL FROM PAGE 2		
57	WEIGHT EMPTY		

MIL-STD-1374 PART I

GROUP WEIGHT STATEMENT
USEFUL LOAD AND GROSS WEIGHT

Page ______
Model ______
Report ______

Name ______
Date ______

1	LOAD CONDITION								
2									
3	CREW (No)								
4	PASSENGERS (No)								
5	FUEL		Location	Type	Gals.				
6	UNUSABLE								
7	INTERNAL								
8									
9									
10									
11	EXTERNAL								
12									
13									
14	OIL								
15	TRAPPED								
16	ENGINE								
17									
18	FUEL TANKS (Location)								
19	WATER INJECTION FLUID (Gals.)								
20									
21	BAGGAGE								
22	CARGO								
23									
24	GUN INSTALLATIONS								
25	GUNS	Location	Fix. or Flex	Quantity	Caliber				
26									
27									
28	AMMO.								
29									
30									
* 31	SUPP'TS								
** 32	WEAPONS INSTALL. (Incl. Submarine Detection Expendables)								
33									
34									
35									
36									
37									
38									
39									
40									
41									
42									
43									
44									
45									
46	EQUIPMENT								
47									
48	SURVIVAL KITS & LIFE RAFTS								
49									
50	OXYGEN								
51									
52									
53									
54									
55	TOTAL USEFUL LOAD								
56	WEIGHT EMPTY								
57	GROSS WEIGHT								

*If Removable and Specified as Useful Load.

**List Stores, Missiles, Sonobuoys, etc. Followed by Racks, Launchers, Chutes, etc. Not Part of Weight Empty. List Identification, Location, and Quantity for All Items Shown Including Installation.

MIL-STD-1374 PART I

GROUP WEIGHT STATEMENT
DIMENSIONAL AND STRUCTURAL DATA

Name ____________ Page ____________

Date ____________ Model ____________

Report ____________

1	WING, ROTOR & TAIL GROUPS	Span or Radius (Ft)	Span at **** 25% Chord	Theo Root ** Chord (In)	Max Thick ** Root Chord (In)	Theo Tip Chord (In) **	Max Thick ** Tip Chord (In)
2	WING						
3							
4	MAIN ROTOR (Blades/Rotor)						
5	TAIL ROTOR (Blades/Rotor)						
6	HORIZ TAIL						
7	VERT. TAIL						
8							
9	AREAS - (Sq. Ft)	Wing	Main Rotor Blade Area	Tail Rotor Blade Area	Horiz. Tail	Vert. Tail	Dorsal
10	(Theo for Wing & Rotor, All Others Exposed)						
11		Speed Brks.	Flaps (L.E.)	Flaps (T.E.)	Slats	Spoilers	Ailerons
12	AREAS - (Sq. Ft.)						
13	BODY & NACELLE GROUPS	Length (Ft.)	Depth (Ft.)	Width (Ft.)	Wetted Area Sq Ft	Vol. (Cu. Ft.)	Vol Press Cu Ft
14	FUSELAGE or HULL						
15	BOOMS						
16	NACELLES						
17							
18							
19	ALIGHTING GEAR GROUP	Length - Oleo Ext.		Oleo Travel		Length - Arrest Hook	
20		Axle to ℄ Trunnion		Ext to Collapsed		Hook Trunnion to Pt	
21	LOCATION						
22	DIMENSIONS (Inches)						
23							
24	PROPULSION GROUP						
25	ENGINES	S.L.S. Thrust in Lbs./Eng. with Afterburner		S.L.S. Thrust in Lbs./Eng. without Afterburner		Max S.L.S. Shaft HP	Shaft RPM at Max HP
26	MAIN						
27	AUXILIARY						
28	ROTOR DRIVE SYSTEM	Design H.P.	Input R.P.M.	Output RPM at Rotor	Inter Rotor RPM	Number Gear Boxes	
29							
30		Protected		Unprotected		Integral	
31	FUEL - INTERNAL *** LOCATION	No. Tanks	Gallons	No Tanks	Gallons	No. Tanks	Gallons
32	WING						
33	FUSELAGE						
34	- EXTERNAL ***						
35							
36	OIL						
37	ELECTRICAL & LOAD & HANDLING GROUPS	Quan Main Generators	Generator Output DC	Generator Output AC		Cargo Floor Area	
38							
39							
40	STRUCTURAL DATA - CONDITION	Body Plus Int Content Lbs	External Wt on Body	Fuel in Wings Lbs		Design Gross Weight	Ult. L F
41	FLIGHT - MANEUVER						
42	- GUST						
43	LANDING						
44							
45	MAX GROSS WITH ZERO WING FUEL						
46	CATAPULTING						
47	LIMIT LANDING SINK SPEED (Ft./Sec.)						
48	Lift Assumed for Landing Design Condition % W						
49	STALL SPD. - LDG CONFIG - POWER OFF						
50	Pressurized Cabin Ult Design Press Differential Flight P.S.I.						
51	ROTOR TIP SPD AT DESIGN LIMIT	R.P.M	Power	Ft./Sec	Contractor Design Factor		
52							
53	% DESIGN LOAD	Wing		Rotor		Rotor	
54	DESIGN SPEED AT S.L. (Knots)	Level		Dive			
55	DESIGN SPD. AT OTHER ALTITUDES		Alt		Alt.		
56							
57	DCPR WEIGHT (Airframe)						

*Nose to aft tip of fuselage (excluding equipment protuberances)

**Parallel to ℄ of ℄ Aircraft for Wing & Tail Insert inches from ℄ Rotor for Rotors

***Total Usable Capacity

****Insert inches from ℄ Rotor to Blade Attachment for Rotors

GROUP WEIGHT STATEMENT
DESCRIPTION OF DIMENSIONAL
AND STRUCTURAL DATA

Page ____________
Model ____________
Report ____________

Name ____________
Date ____________

1							
2	Refer to Paragraph 5.1.1.4 of						
3							
4	"Detailed Requirements for Instructions for Use						
5							
6							
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11							
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57							

GROUP WEIGHT STATEMENT

Name ____________ Page ____________

Date ____________ Model ____________

Report ____________

AIRFRAME WEIGHT

The Airframe Weight to be entered on line 57 of page 5 of the Group Weight Statement should be derived here in detail showing those items deducted from weight empty as required by the document "Cost Information Reports (CIR) for Aircraft, Missiles, and Space Systems" dated 21 April, 1966, or subsequent revisions thereto. Airframe weight is the same as previously called AMPR and DCPR and is not to be confused with "Work Breakdown Structure (WBS) Airframe Cost Definition."

WEIGHT EMPTY ____________

DEDUCT THE FOLLOWING ITEMS

(ITEMIZE)

____

____

____

____

____

AIRFRAME WEIGHT ____________

4.10 PERFORMANCE CALCULATIONS SUBPROGRAM

The flow chart of the control loop for the performance calculations subprogram is shown in Figure 4-46. This routine monitors the flow during calculation of mission performance data and calculates the total fuel required at the end of the mission.

4.10.1 Taxi Calculations Subroutine

The taxi calculations subroutine (specified by SGTIND = 1), calculates the fuel required to taxi at ground idle engine setting for a specified period of time. For aircraft which have independent lift propulsion systems (LFTIND = 1), the program will calculate taxi performance for either primary engines operating alone, or both primary and lift engines operating. This is accomplished by means of the input constant k_{FL}. If k_{FL} is input as 0, the program will consider only primary engines in operation in determining fuel flow rates. If k_{FL} is input as unity, the program will include both primary and lift propulsion systems in calculating the fuel flow rates and the corresponding reduction in aircraft gross weight. Figure 4-47 is a flow chart of this subroutine.

Input to this subroutine consists of the time for taxi, value of k_{FL}, and atmospheric conditions.

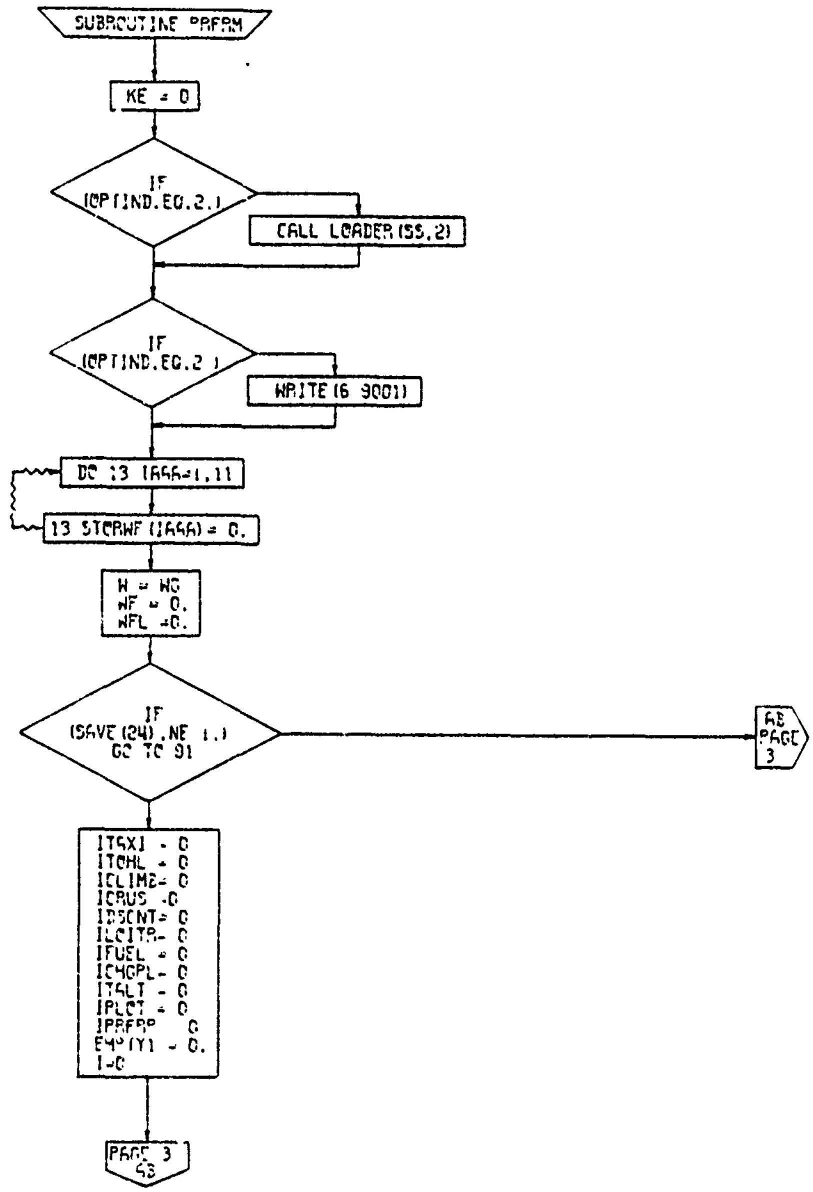


Figure 4-46. Performance Calculations Subroutine, Flow Chart (Part 1 of 6)

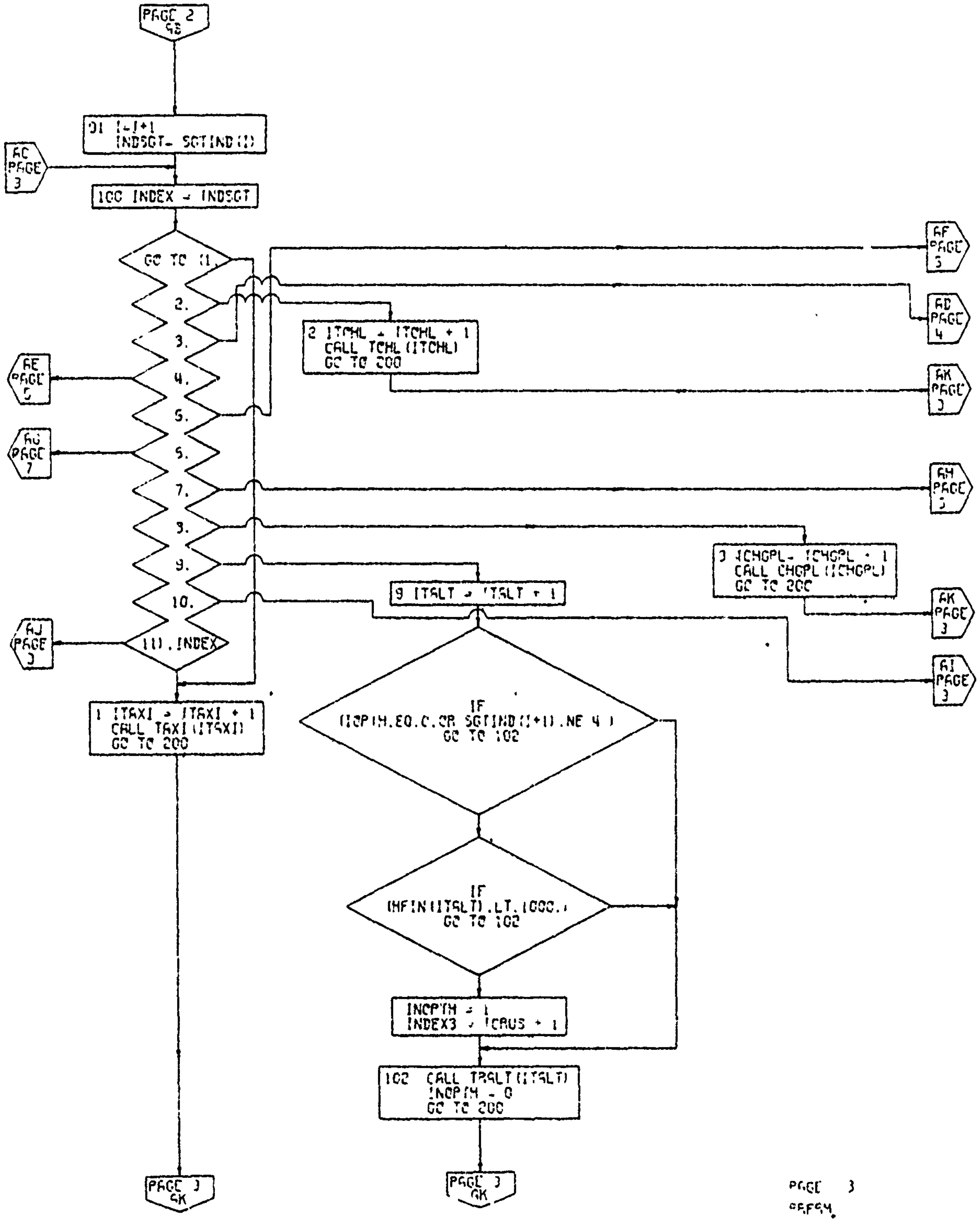
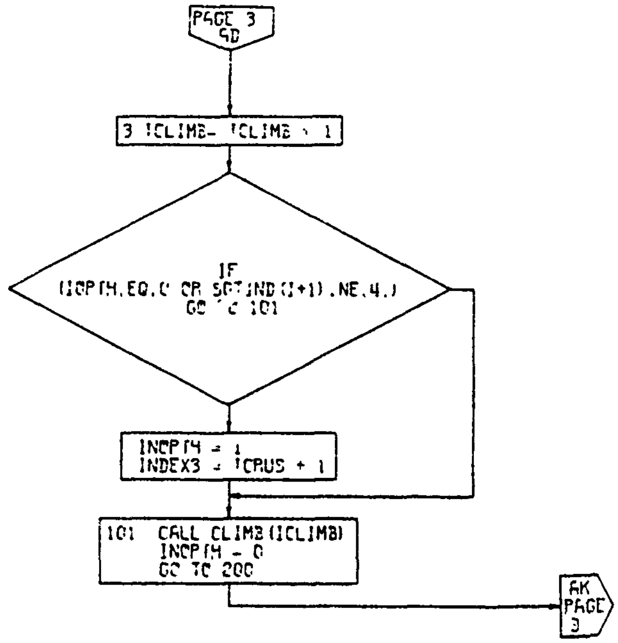


Figure 4-46. Performance Calculations Subroutine, Flow Chart (Part 2 of 6)



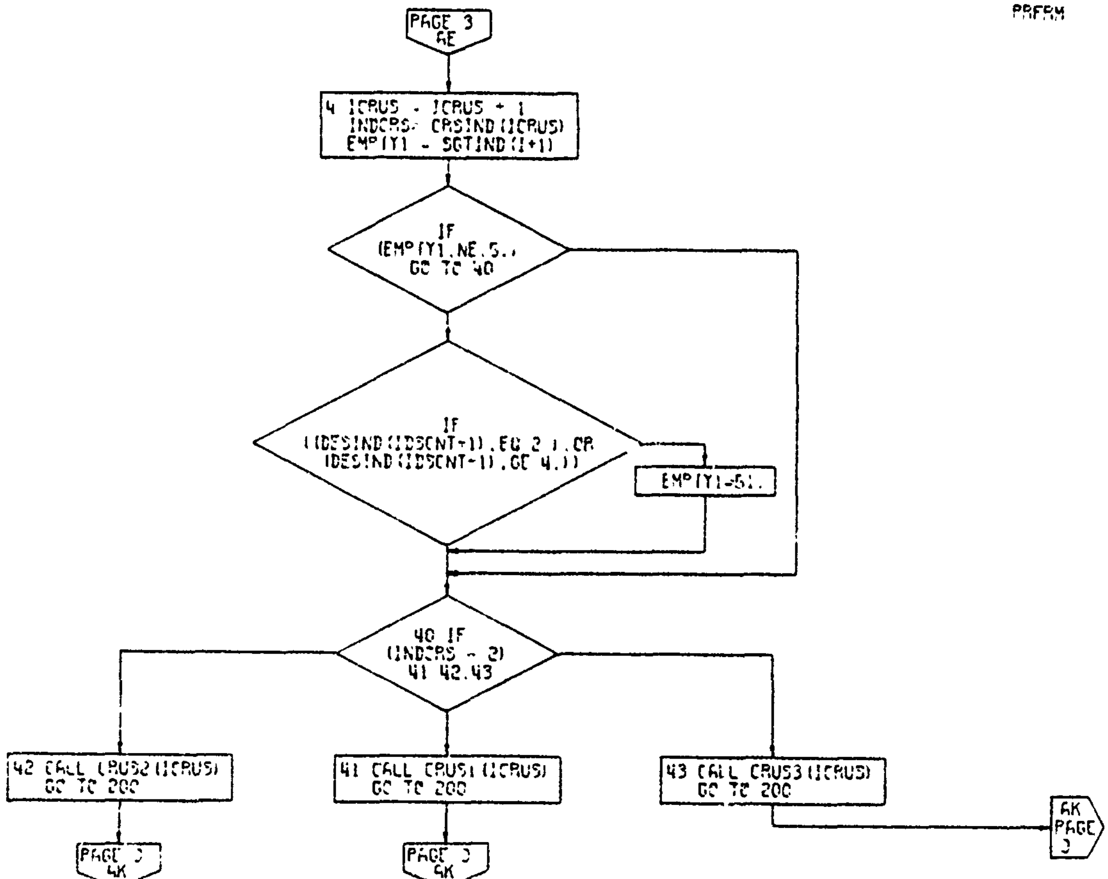
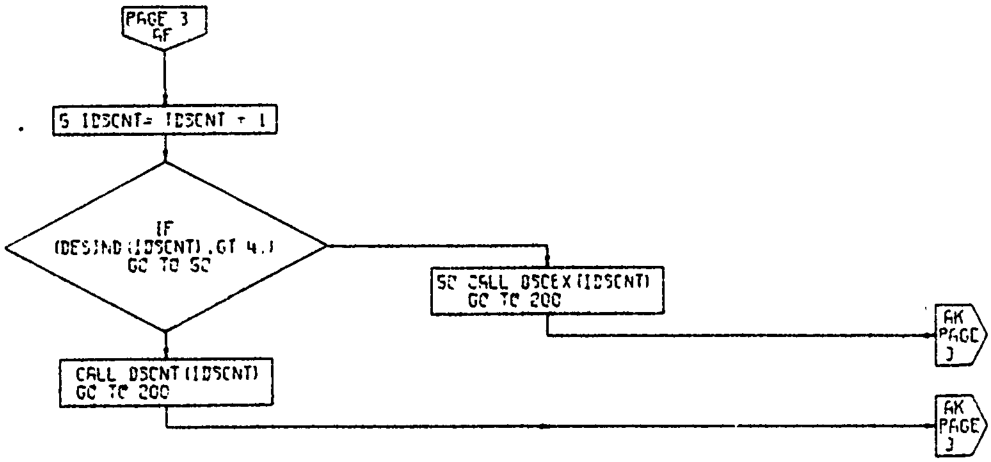
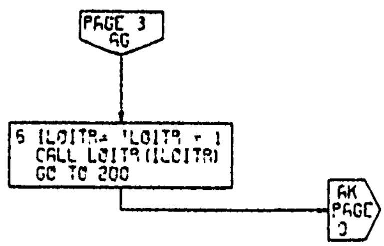


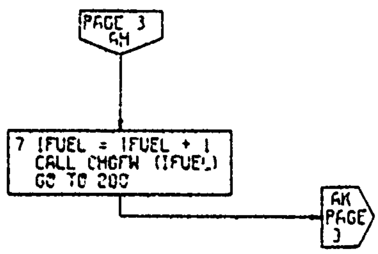
Figure 4-46. Performance Calculations Subroutine, Flow Chart (Part 3 of 6)



PAGE 5
PRFRM



PAGE 7
PRFRM



PAGE 9
PRFRM

Figure 4-46. Performance Calculations Subroutine, Flow Chart (Part 4 of 6)

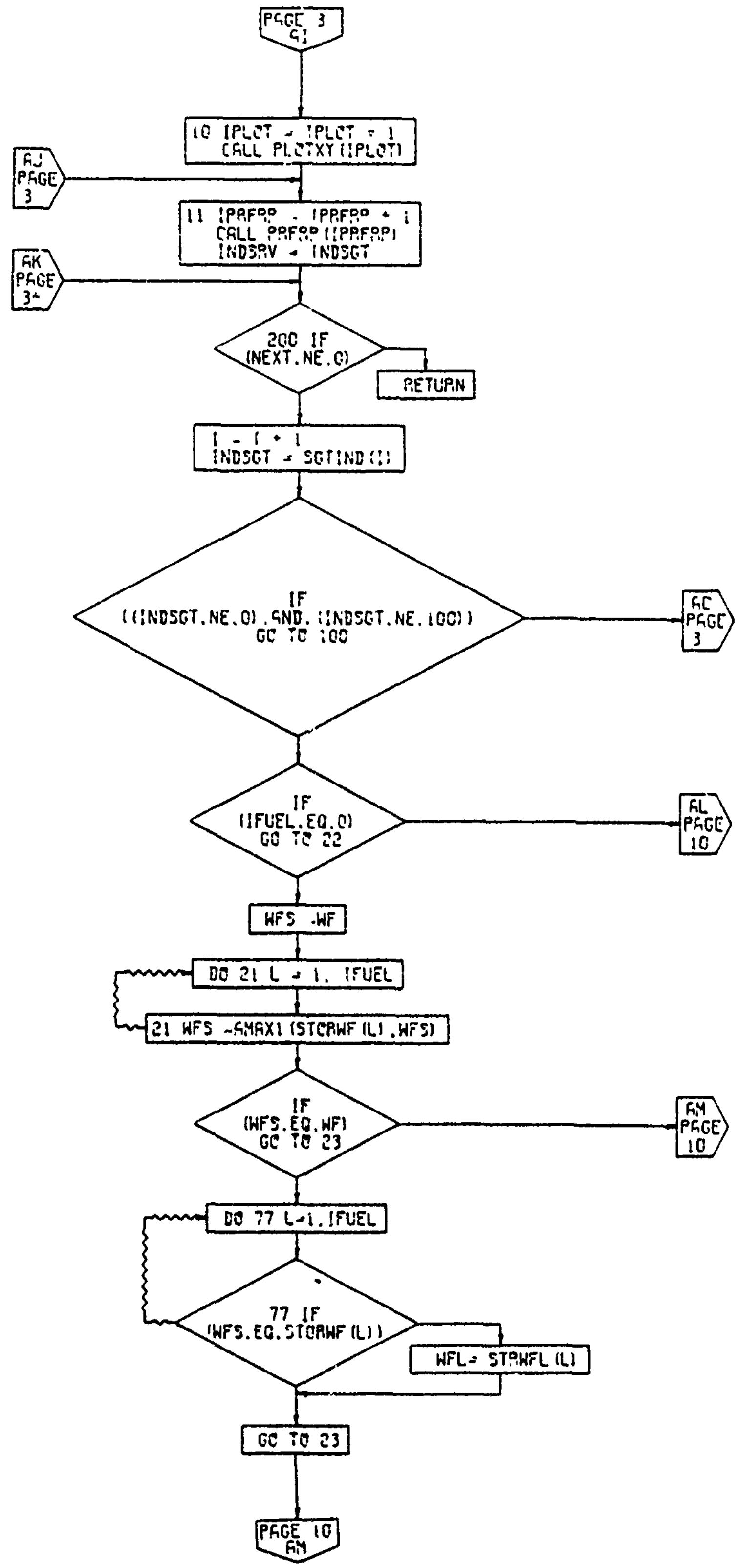


Figure 4-46. Performance Calculations Subroutine, Flow Chart (Part 5 of 6)

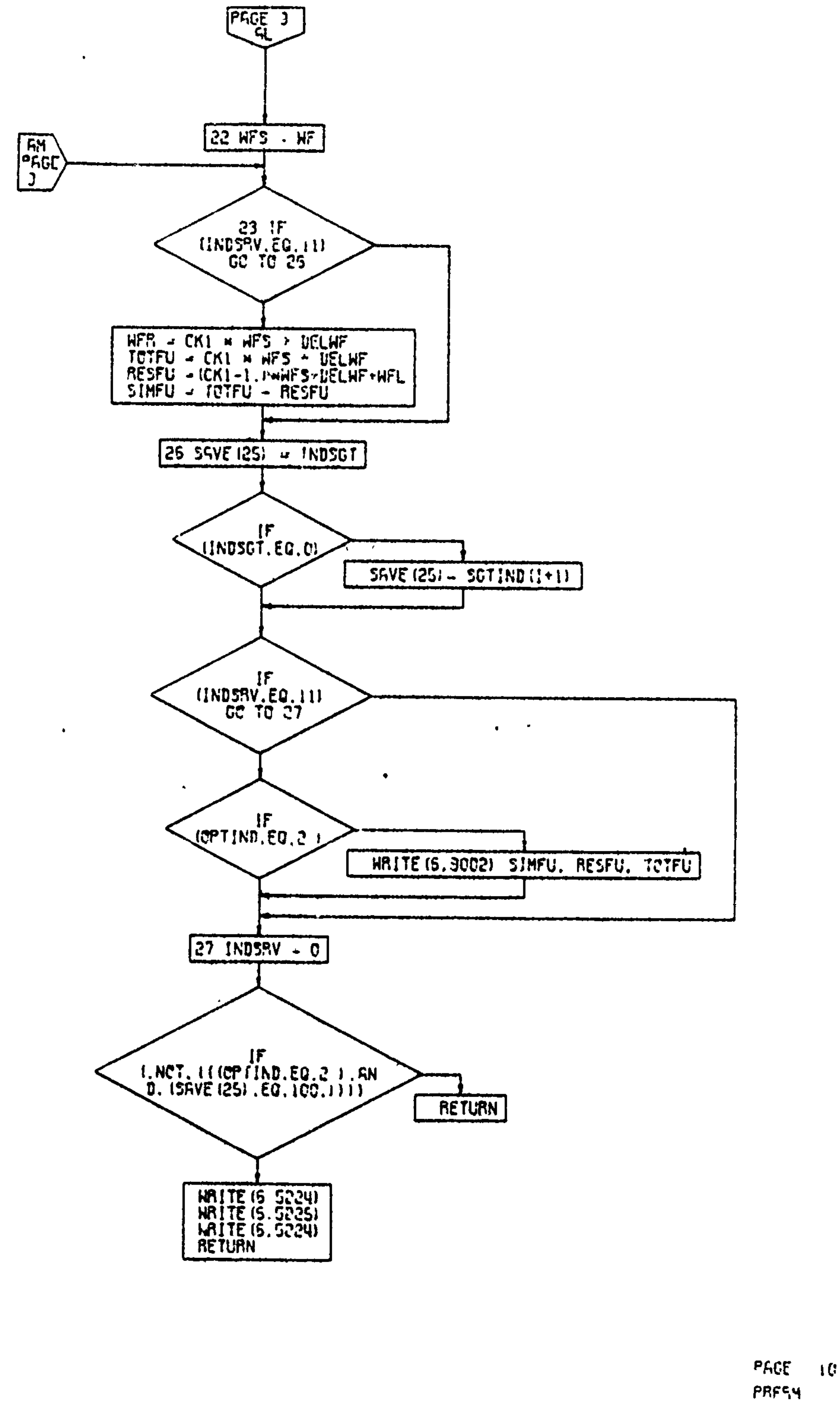


Figure 4-46. Performance Calculations Subroutine, Flow Chart (Part 6 of 6)

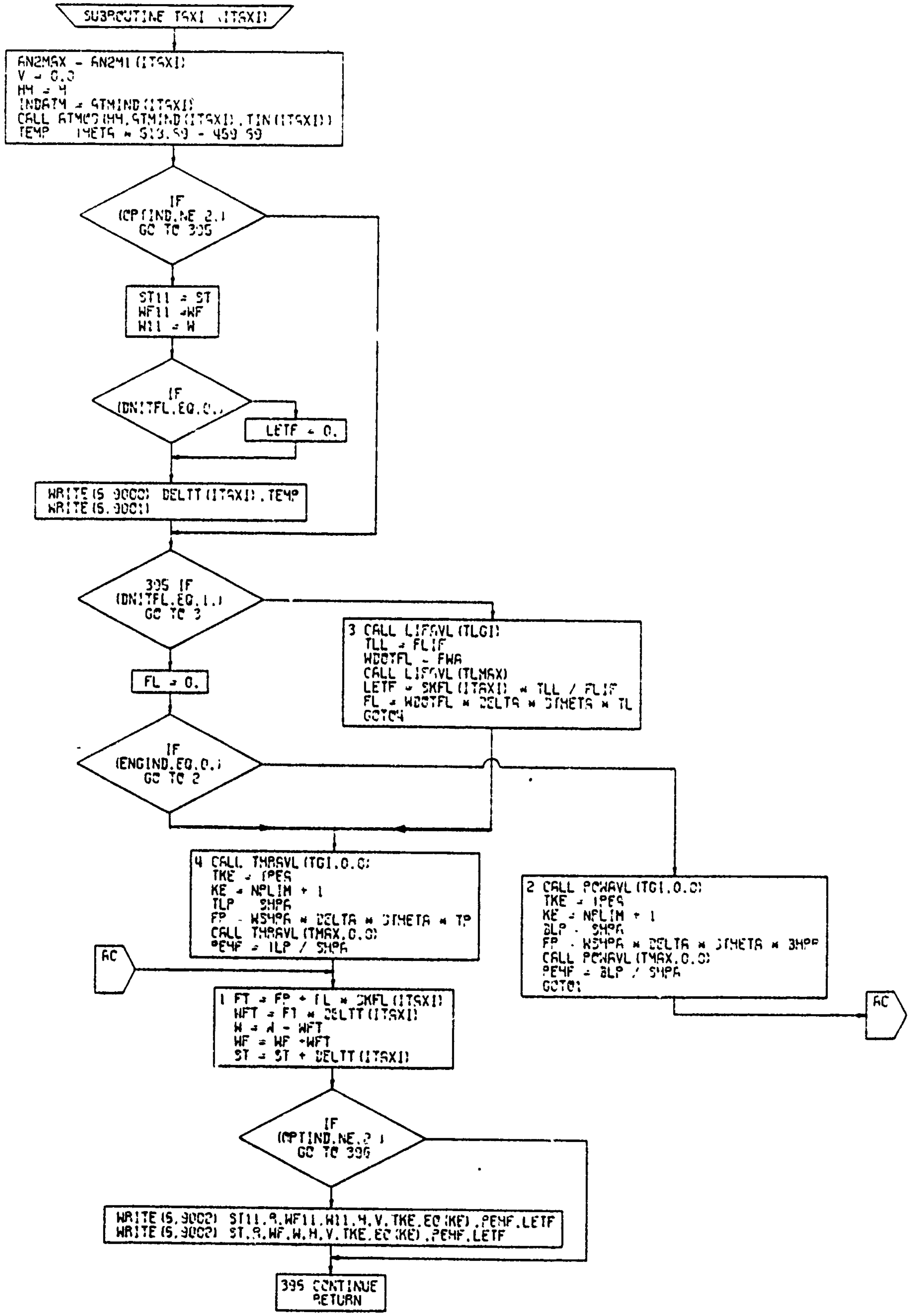


Figure 4-47. Taxi Calculations Subroutine, Flow Chart

4.10.2 Takeoff, Hover, and Landing Calculations Subroutine

The takeoff, hover, and landing calculations subroutine (specified by SGTIND = 2) will calculate the thrust or power required and corresponding fuel flow rates during simulated takeoff/hover/landing operations. Three options are available, specified by the input indicator TOLIND:

TOLIND = 1 - Input required thrust-weight ratio. Program will use maximum thrust from lift engines before augmenting with primary engines (if necessary). If only primary engines are on aircraft (LFTIND = 0), required thrust level will be taken from primary engines.

TOLIND = 2 - This option must not be used if LFTIND = 0. Input required thrust-weight ratio. Program will take an equal fraction of power available from lift engines and primary engines.

TOLIND = 3 - Input required power fraction (fraction of maximum available power) for primary engines and/or lift engines. Program will calculate thrust-weight ratio.

In all cases, the program will print out the power fraction and thrust-weight ratio. The program will permit operation at power fractions greater than 1.0 (more than 100 percent of available power) in order to make it easier to perform studies in which engine power is being varied parametrically to satisfy specified takeoff or landing requirements at a remote site. The program will, however, print a cautionary note that power fraction exceeds 100 percent.

Propulsive efficiencies for both primary and lift propulsion systems can be input to this subroutine. The value of efficiency relates to the percentage of thrust or power which is doing useful work in the vertical direction. Thus, the primary engine efficiency η_{P2}, when used with a thrust producing engine (ENGIND = 1) is interpreted as the ratio of thrust of the primary engines in the vertical direction to total engine thrust, and may be used to simulate a turning efficiency of jet engines being used with turning vanes. Similarly, the lift engine efficiency, η_L, may be used to simulate the effect of

control losses on lift engine thrust. If the primary engines being used are turboshaft (ENGIND = 0) or convertible (ENGIND = 2) engines, the primary propulsive efficiency, η_{p2}, is defined in the more normal manner as a power ratio (rather than a thrust ratio).

Figure 4-48 is a flow chart for this subroutine.

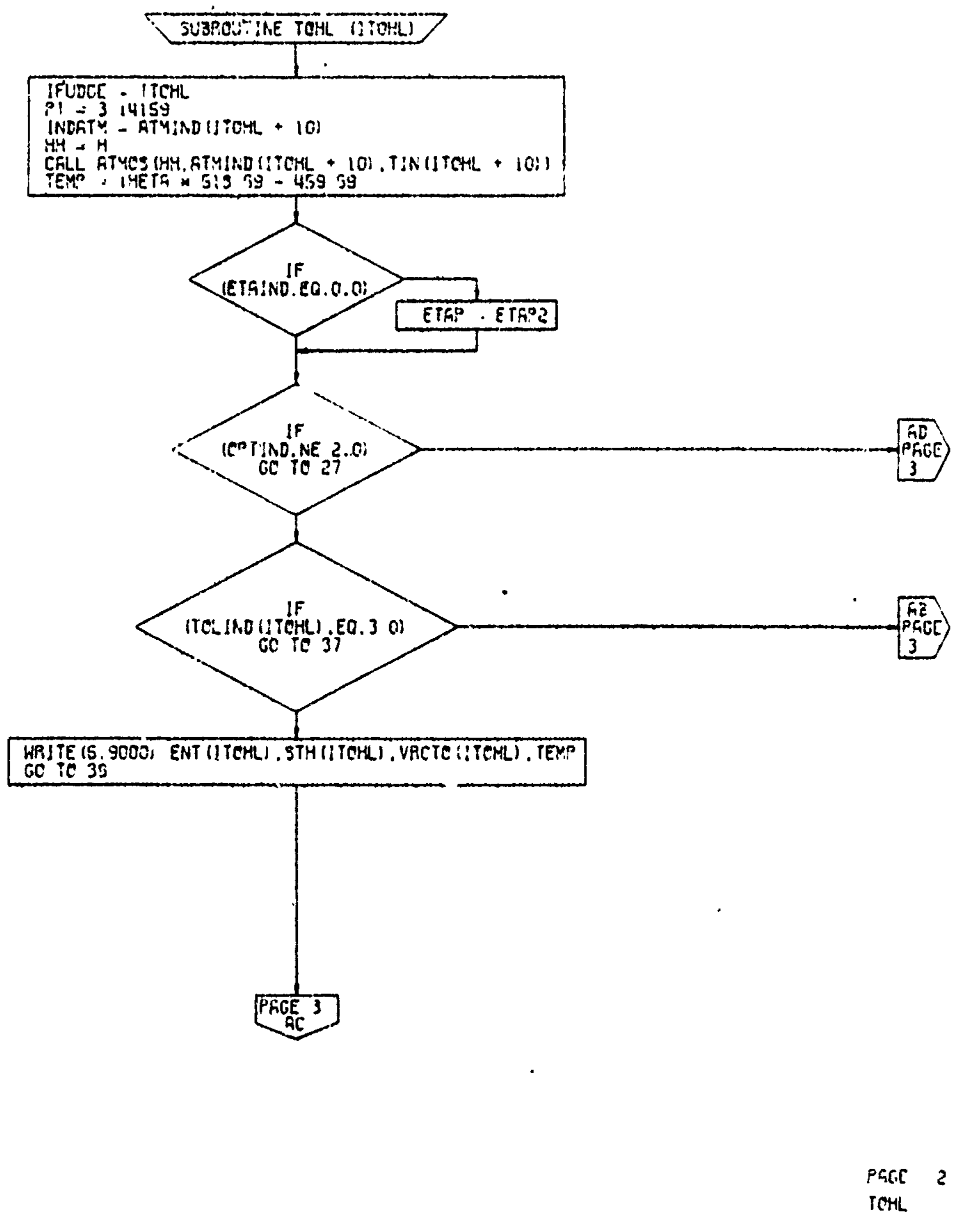


Figure 4-48. Takeoff, Hover, Land Subroutine Flow Chart (Part 1 of 12)

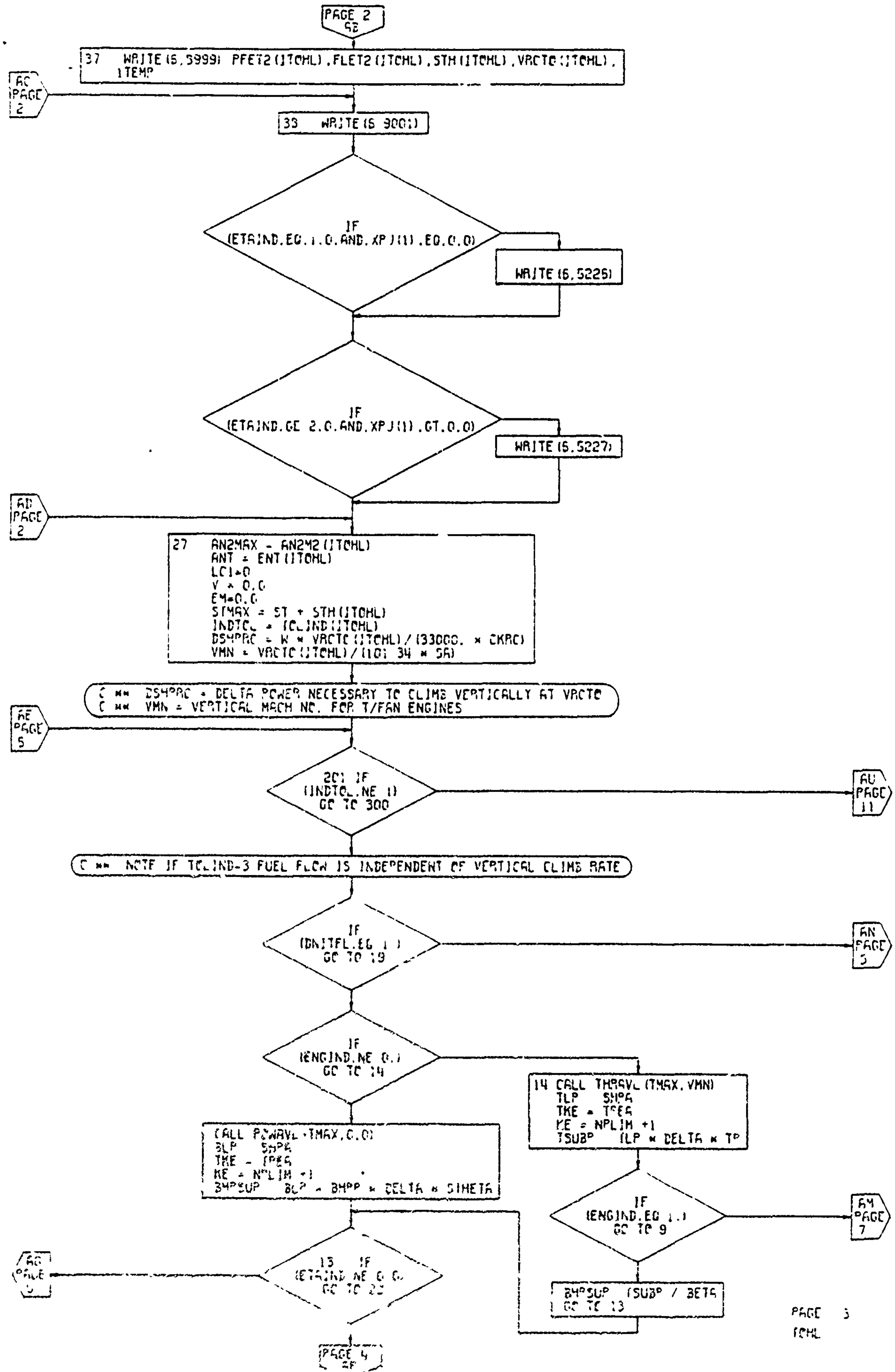
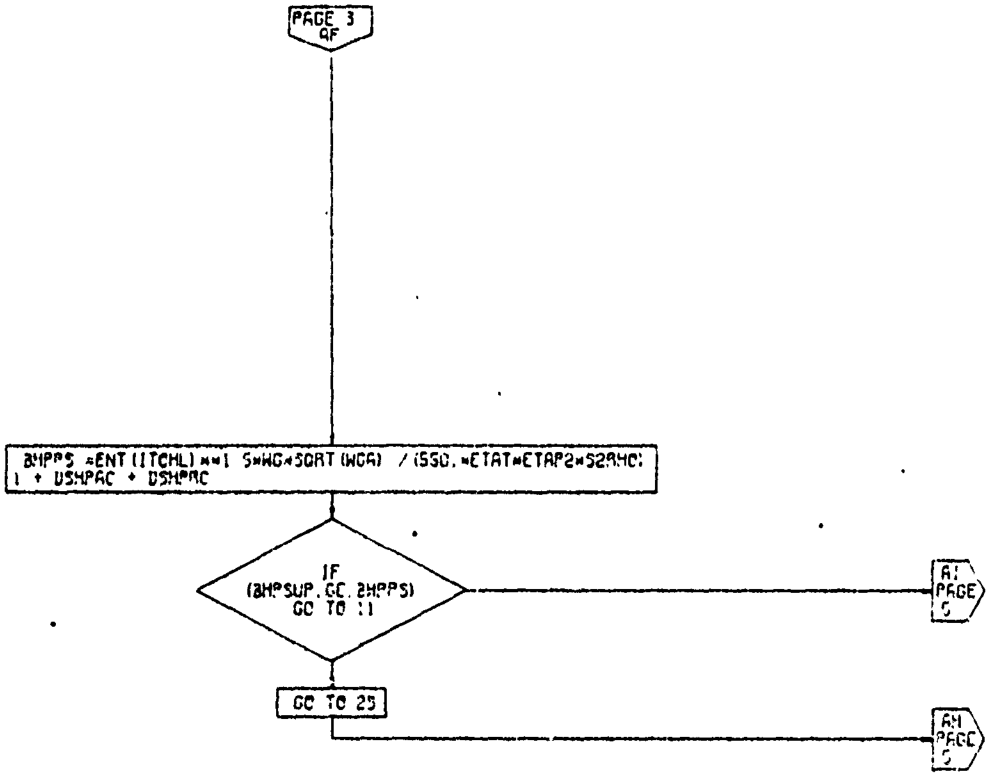


Figure 4-48. Takeoff, Hover, Land Subroutine, Flow Chart (Part 2 of 12)



PAGE 4
TCHL

Figure 4-48. Takeoff, Hover, Land Subroutine Flow Chart (Part 3 of 12)

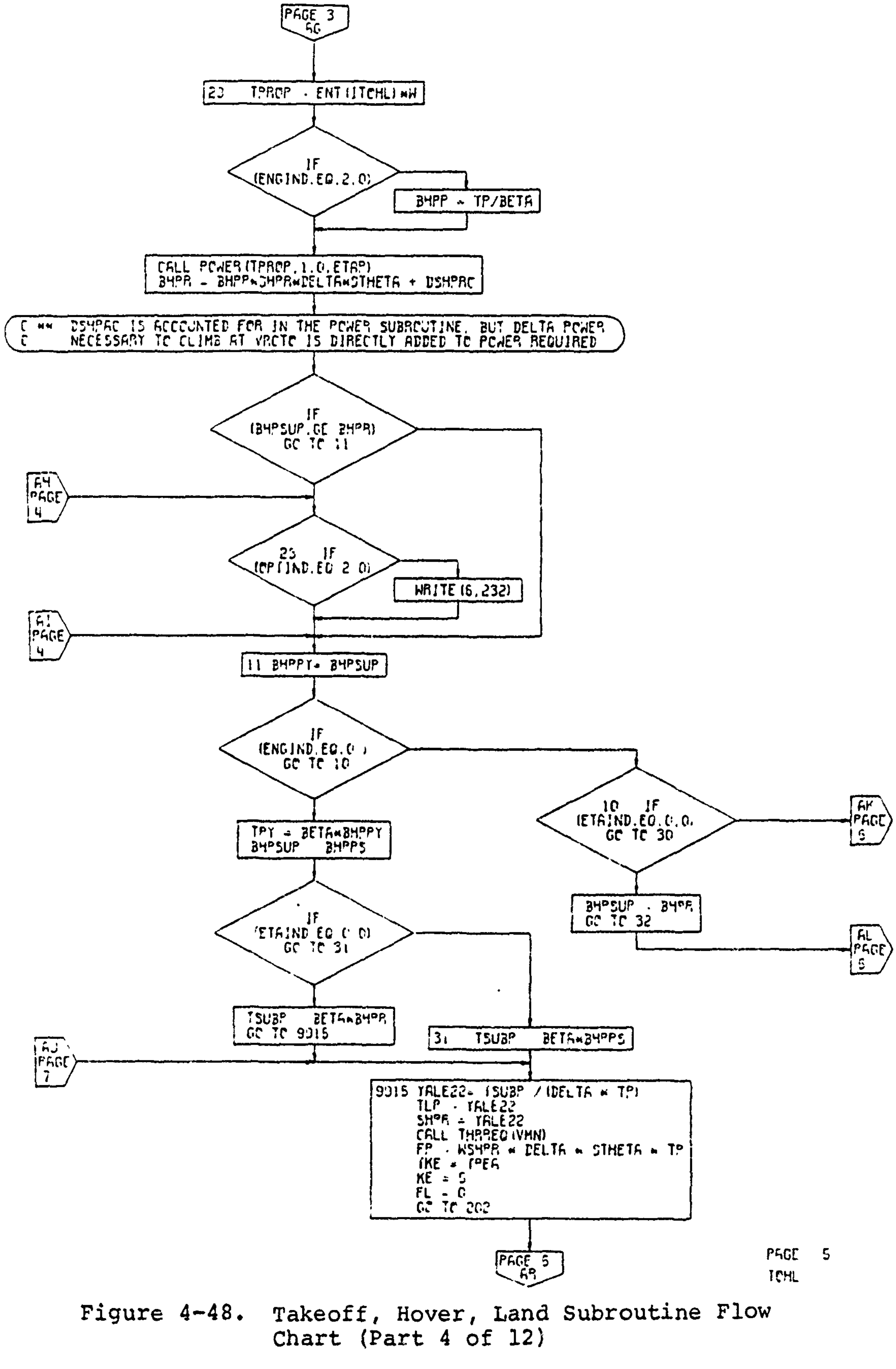


Figure 4-48. Takeoff, Hover, Land Subroutine Flow Chart (Part 4 of 12)

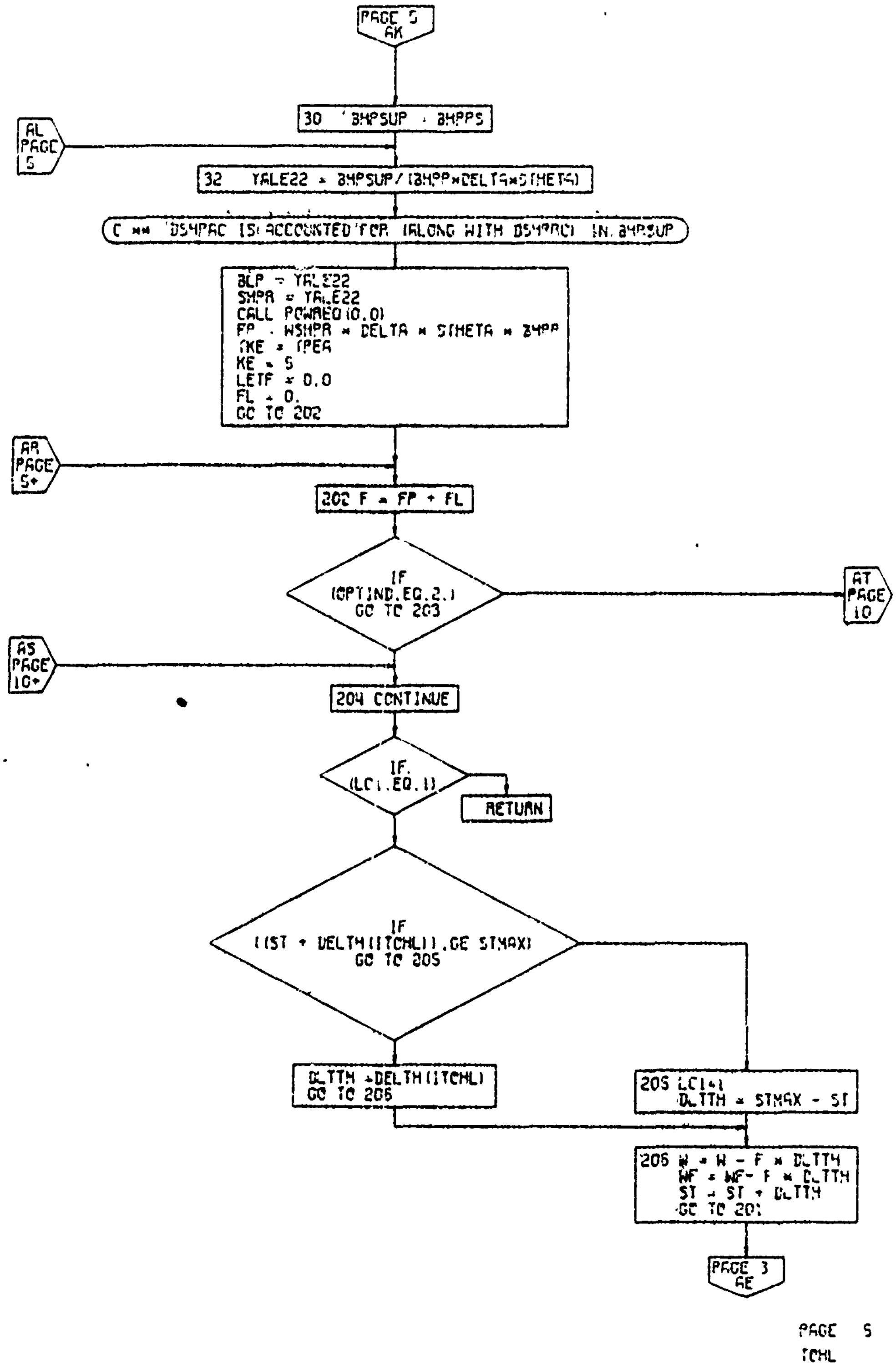
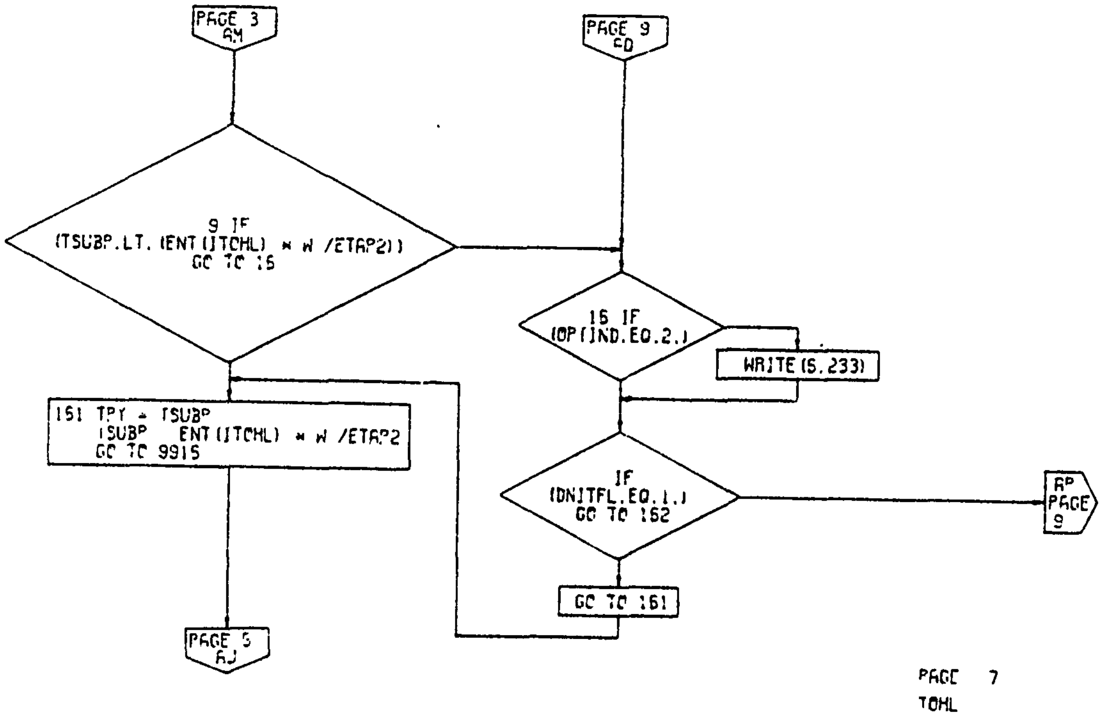


Figure 4-48. Takeoff, Hover, Land Subroutine Flow Chart (Part 5 of 12)



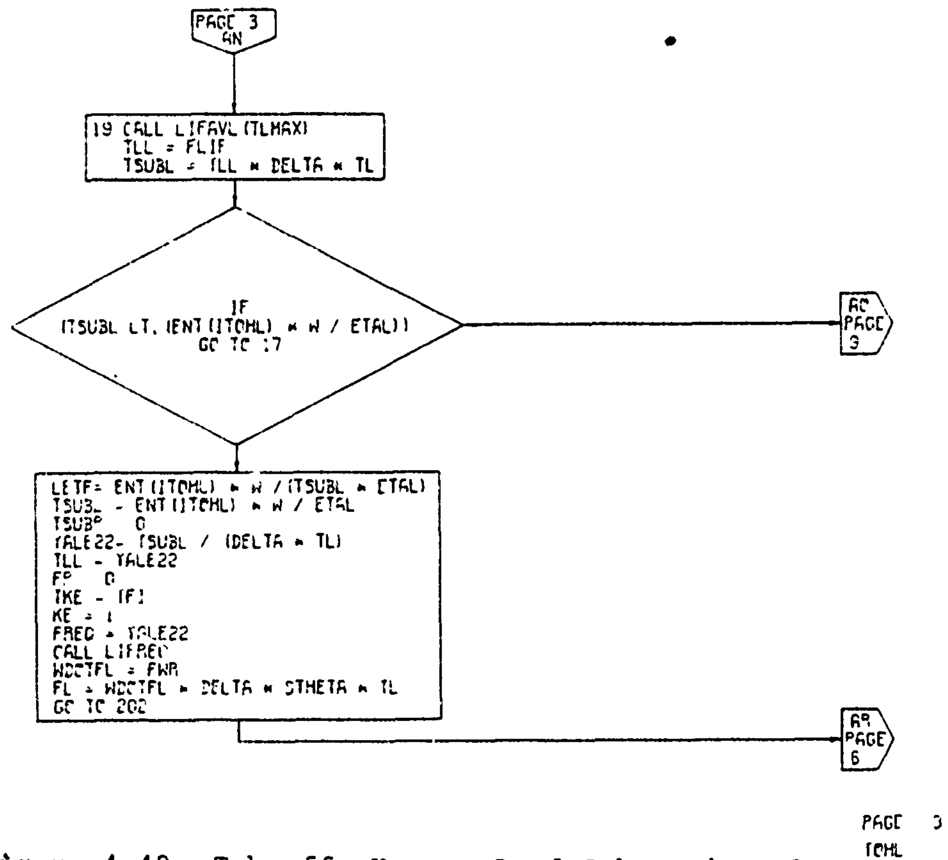


Figure 4-48. Takeoff, Hover, Land Subroutine Flow Chart (Part 6 of 12)

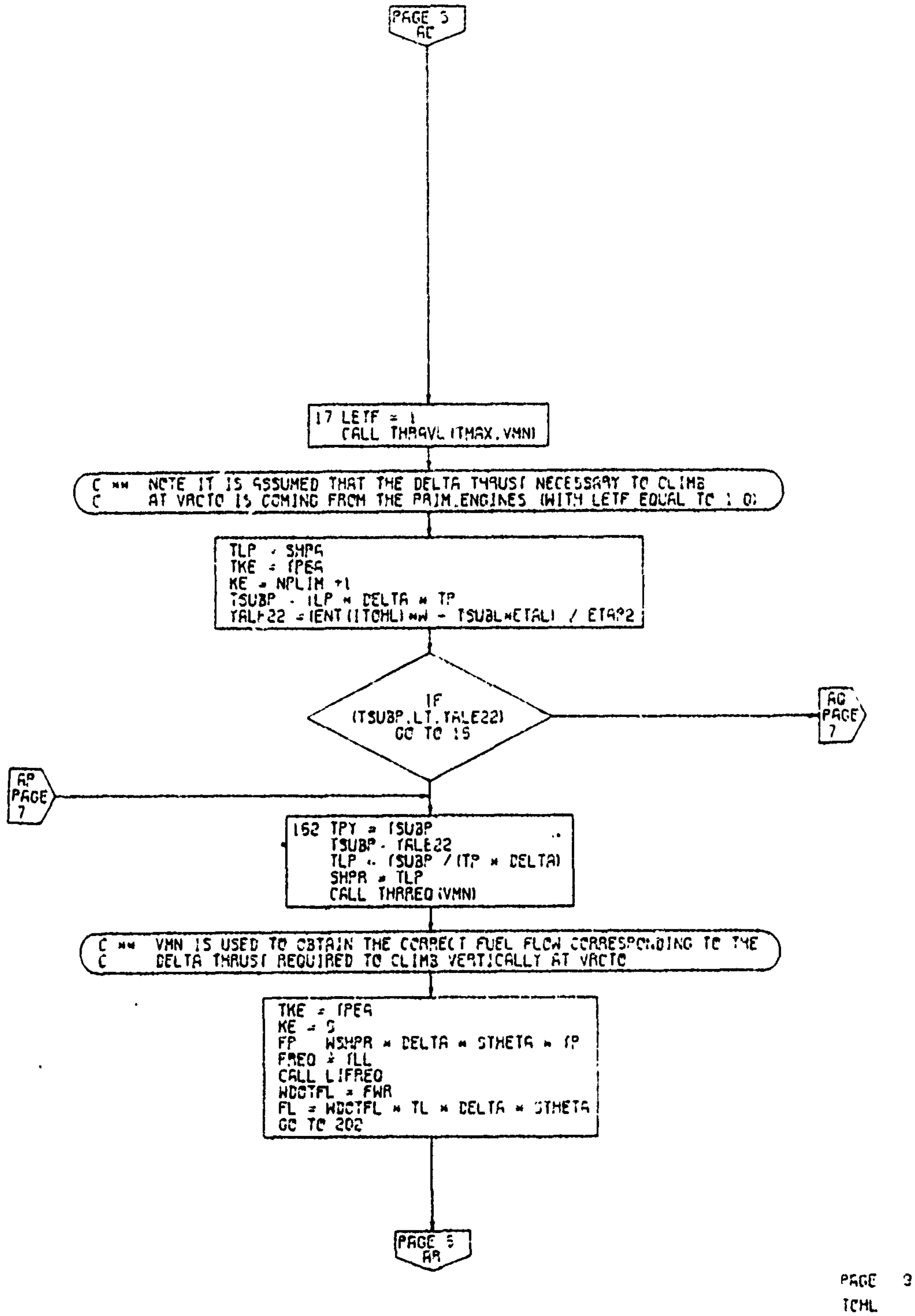


Figure 4-48. Takeoff, Hover, Land Subroutine Flow Chart (Part 7 of 12)

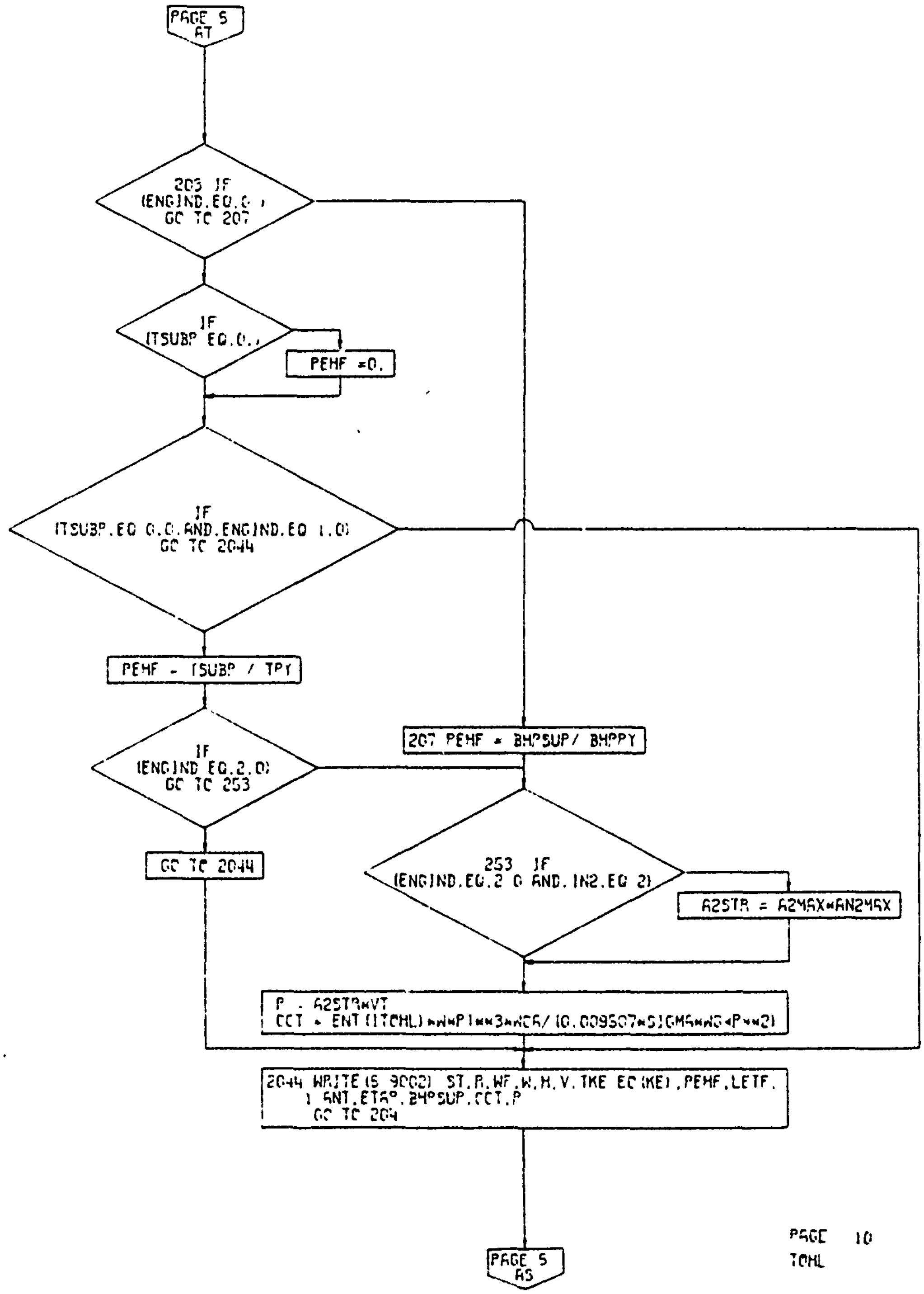


Figure 4-48. Takeoff, Hover, Land Subroutine Flow Chart (Part 8 of 12)

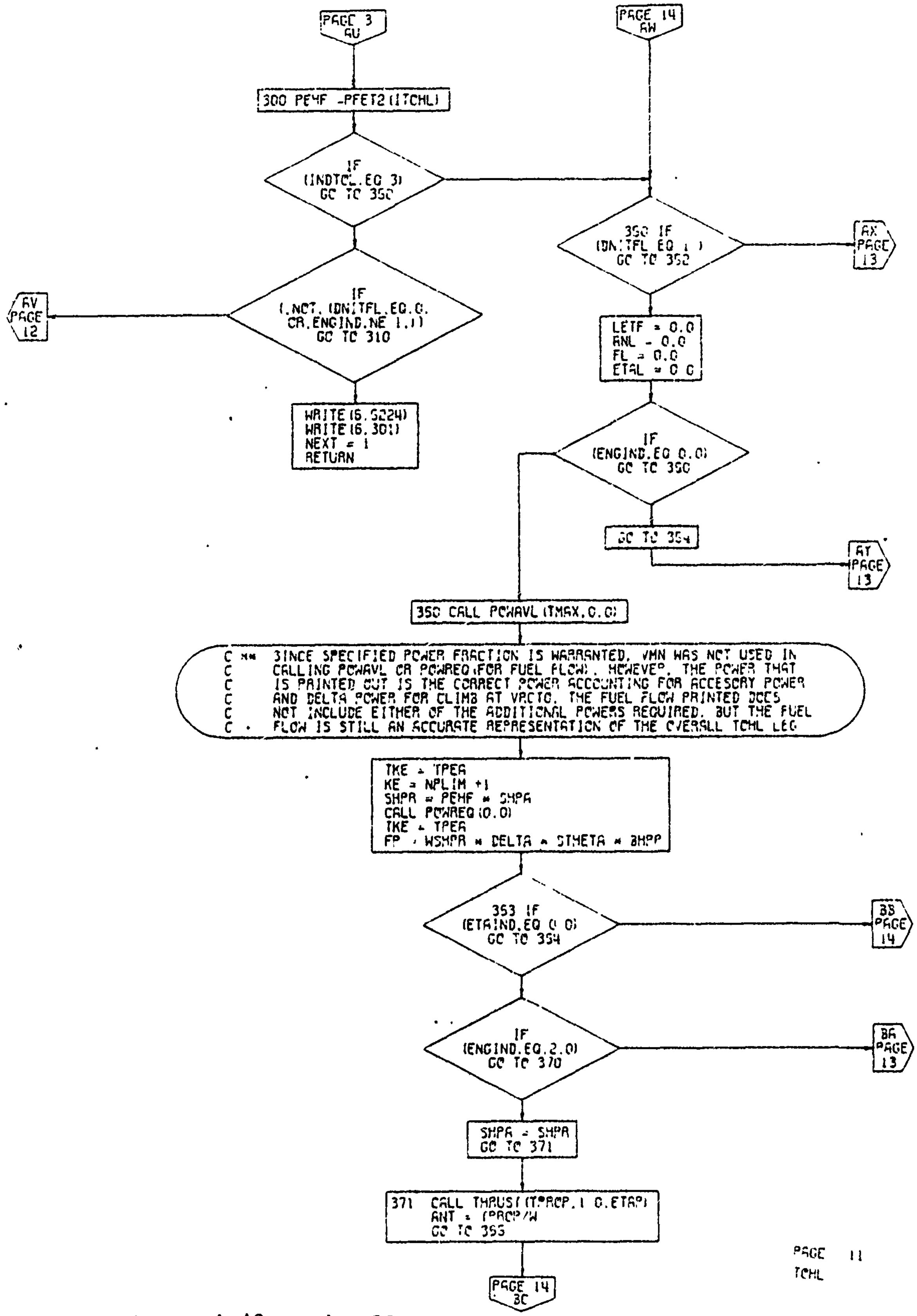


Figure 4-48. Takeoff, Hover, Land Subroutine Flow Chart (Part 9 of 12)

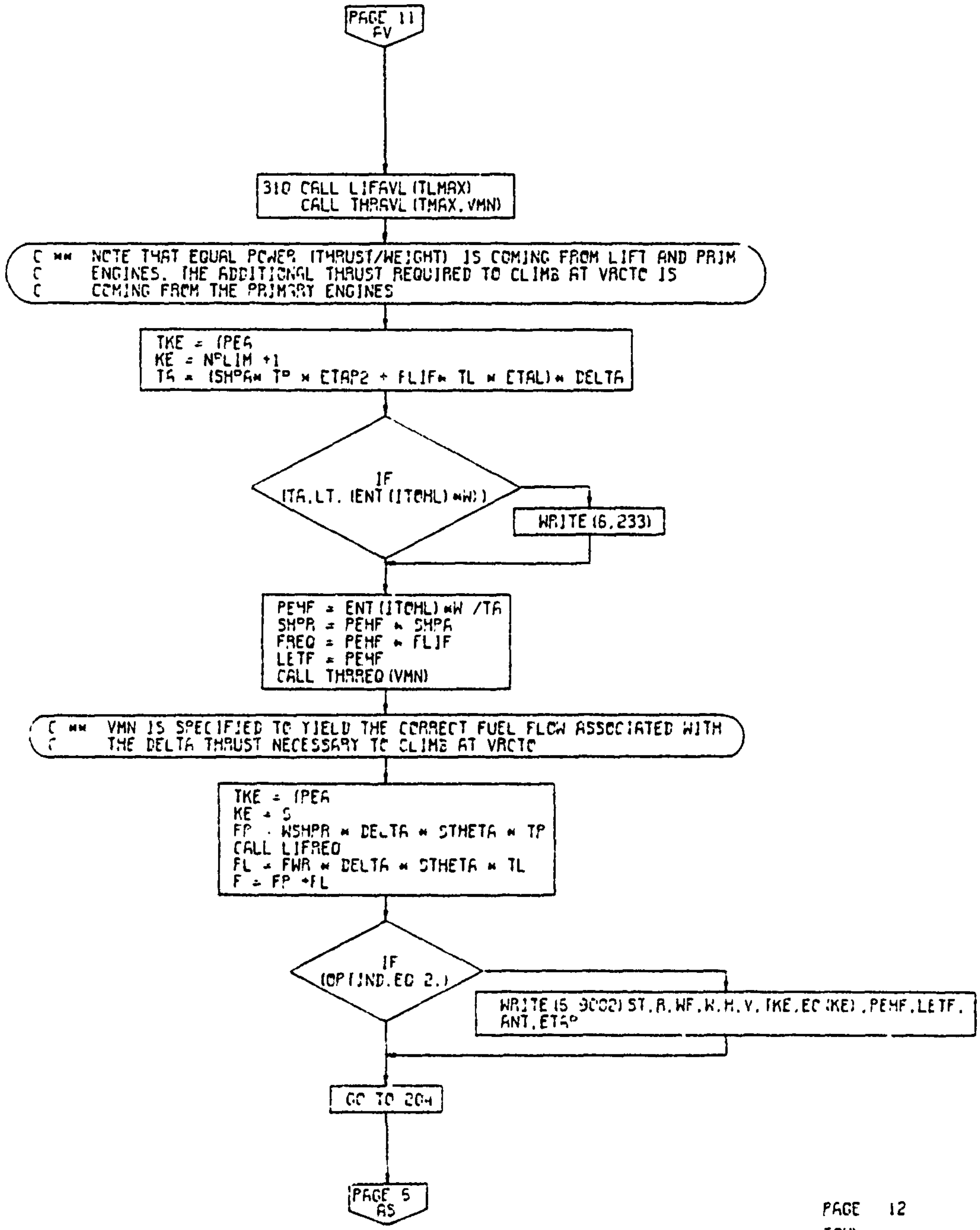


Figure 4-48. Takeoff, Hover, Land Subroutine Flow Chart (Part 10 of 12)

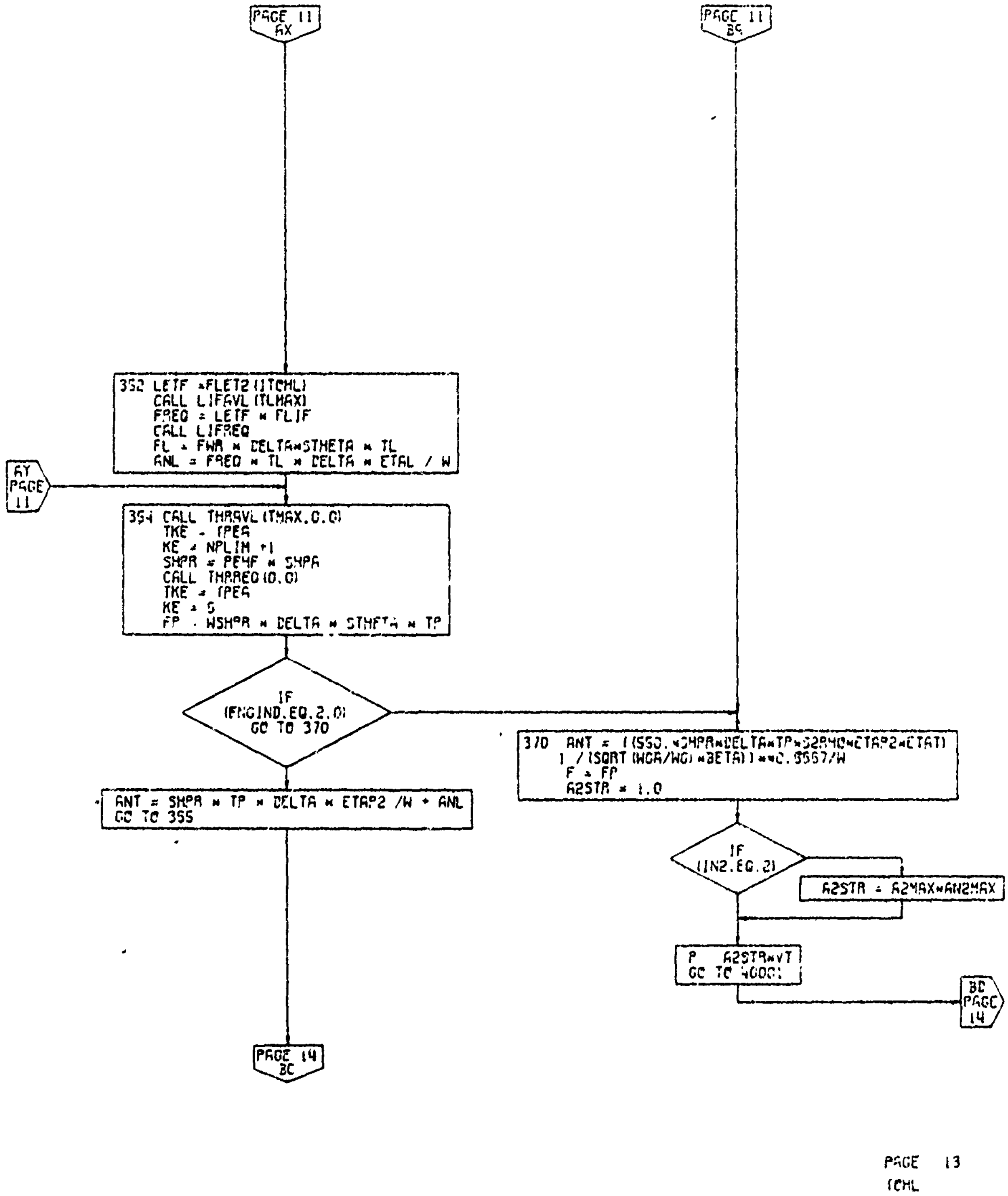


Figure 4-48. Takeoff, Hover, Land Subroutine Flow Chart (Part 11 of 12)

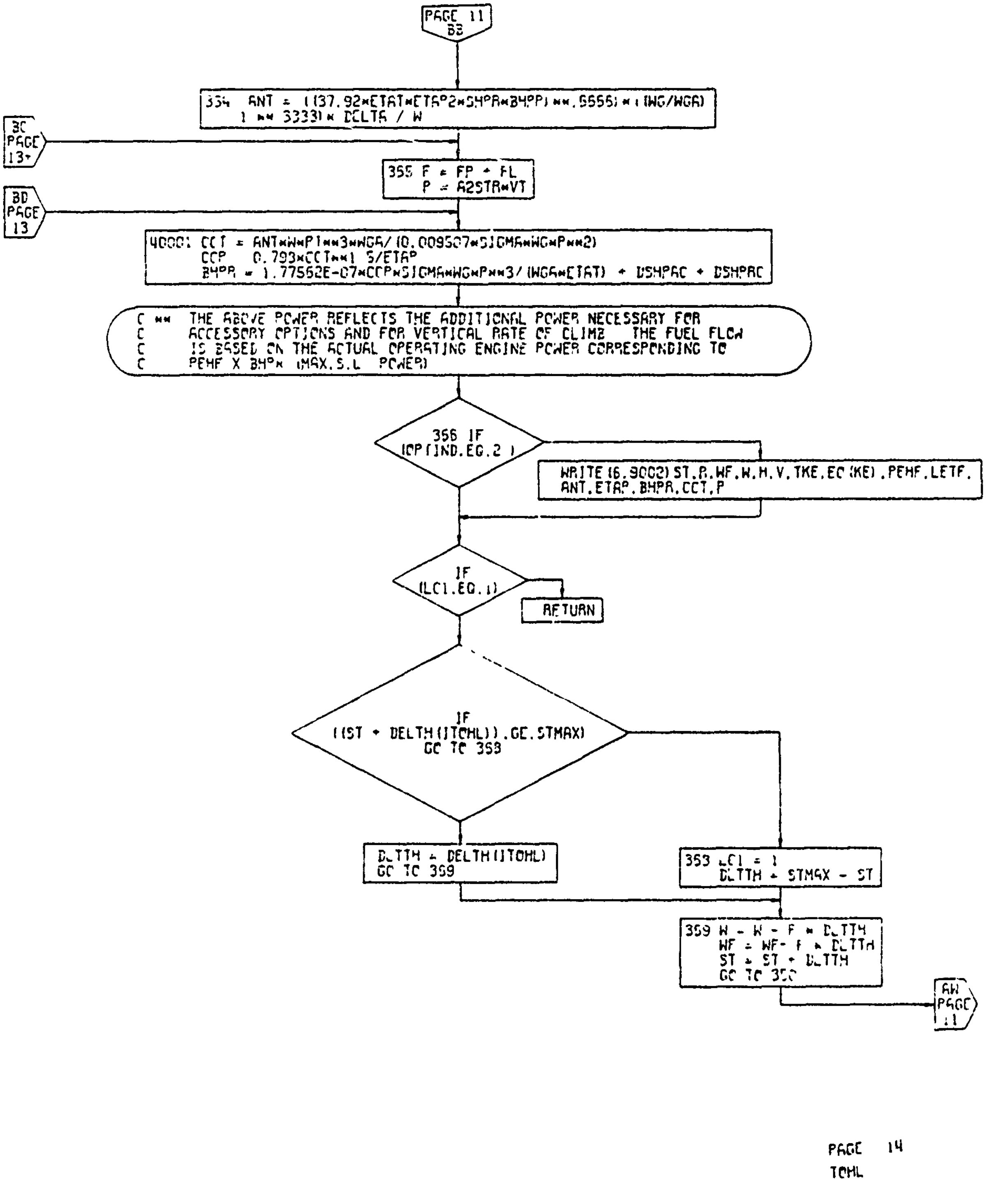


Figure 4-48. Takeoff, Hover, Land Subroutine Flow Chart (Part 12 of 12)

4.10.3 Climb Calculations Subroutine

The third performance segment is a calculation of climb performance. Four options are available, specified by the indicator CLMIND:

CLMIND = 1 - The program calculates performance of the aircraft in a maximum rate of climb ascent limited by maximum operating airspeed, maximum operating Mach number, and maximum body attitude angle. If, at the conditions for best rate of climb, the attitude angle of the aircraft fuselage is greater than the input maximum, the airspeed is increased until the attitude angle restriction is satisfied. In no event will the aircraft be required to fly at an airspeed greater than the input maximum operating airspeed. In the unlikely event that at V_{MO}, M_{MO}, the aircraft rate of climb is sufficiently high to cause the aircraft fuselage attitude angle to exceed the maximum value, the engine power will be reduced to that level necessary to satisfy the attitude angle constraint. The aircraft will then climb at V_{MO}, M_{MO}, at reduced power rating.

CLMIND = 2 - The program calculates the climb performance of the aircraft at specified constant equivalent airspeed limited, as before, by M_{MO}, V_{MO}, and maximum body attitude angle. If the attitude angle exceeds the input maximum, the power level will be reduced.

CLMIND = 3 - Climb performance is calculated at constant specified Mach number. Otherwise, the option is similar to CLMIND = 2.

CLMIND = 4 - Climb will be calculated at constant true airspeed with the same constraints as for CLMIND = 2.

For all options, the user may input the power setting of the engines which will be considered to be the maximum permissible rating. This is accomplished by means of the indicator POWIND:

POWIND = 0:	Maximum	engine rating
POWIND = 1:	Military	
POWIND = 2:	Normal	

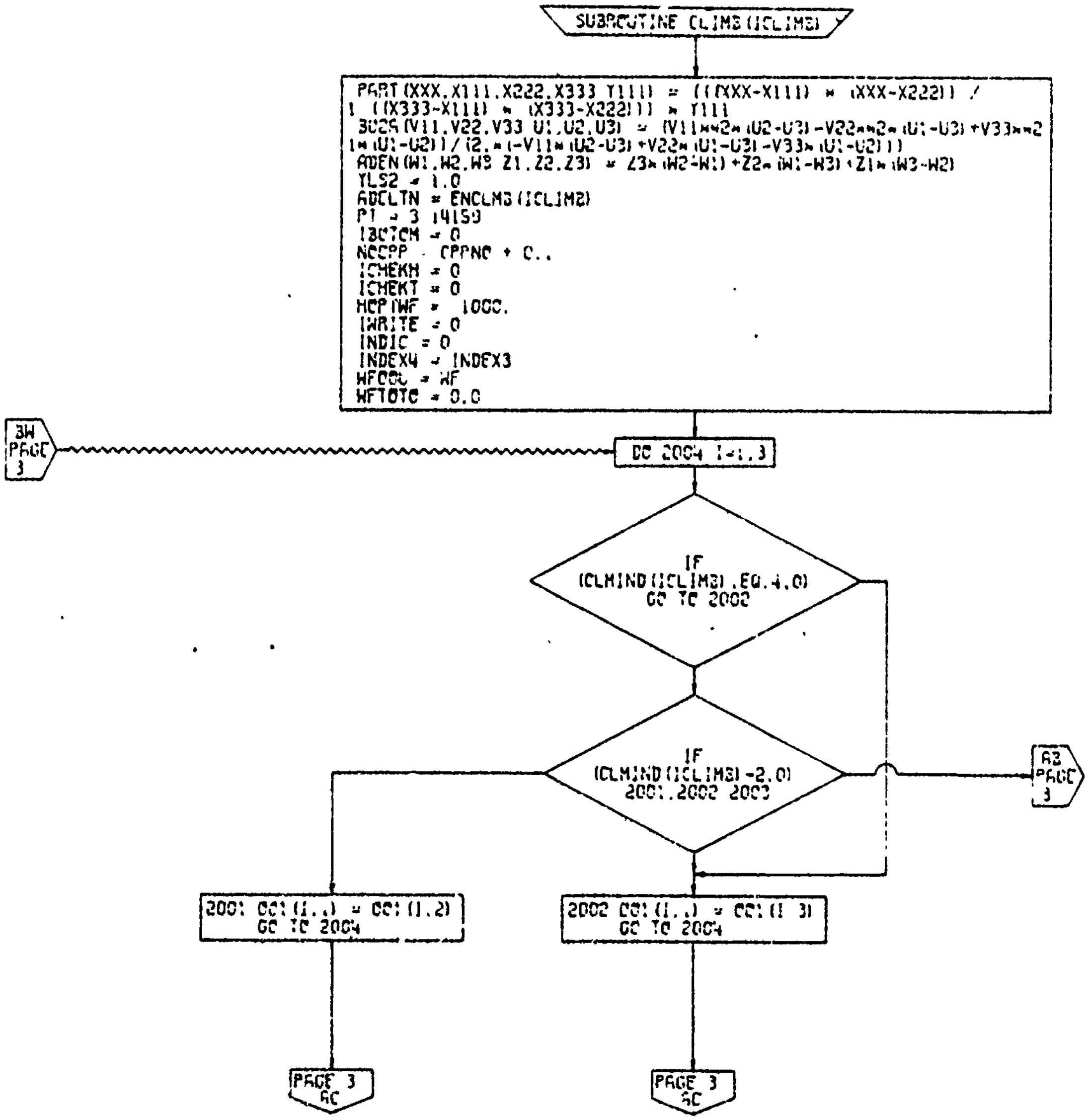
If the limiting speed option (V_{LIM}IND = 1) is used, the climb speed calculated by the program or specified by the user will be automatically monitored by the program to ensure that it does not exceed 250 knots equivalent airspeed at altitudes of 10,000 feet or less.

The climb segment may be used to make energy-maneuverability calculations. To calculate the specific excess power (P_s) at a given value of altitude and true airspeed (or Mach number) and at a desired level of normal load factor, the user may run a climb segment at constant Mach number (CLMIND=3) or constant true airspeed (CLMIND=4). The normal load factor is specified to the program by an input for Δn_{CLIMB}. This input represents the airplane normal load factor in excess of 1 g. For conventional climbs, this parameter should be input as zero. The program printout for rate of climb in feet per minute may be interpreted as the specific excess power (P_s) and converted to units of feet per second, ordinarily used in energy-maneuverability charts.

The user may specify a value for incremental drag coefficient during climb, ΔC_{DCLIMB} to represent variations in store drag.

The input h_{max} has two applications. If $h_{OPT}IND = 1$ (optimum altitude search) and the climb is followed by a cruise, the input value of h_{max} will be interpreted as the maximum flight altitude for the following cruise. If the optimum cruise altitude is determined by the program to be at an altitude less than h_{max}, the climb will terminate at the lower altitude. If an optimum altitude search is not being used or if the following segment is other than a cruise, the input h_{max} is interpreted as the final altitude for the climb segment.

Figure 4-49 is a flow chart for this subroutine.



PAGE 2
CLIMB

Figure 4-49. Climb Subroutine, Flow Chart
(Part 1 of 22)

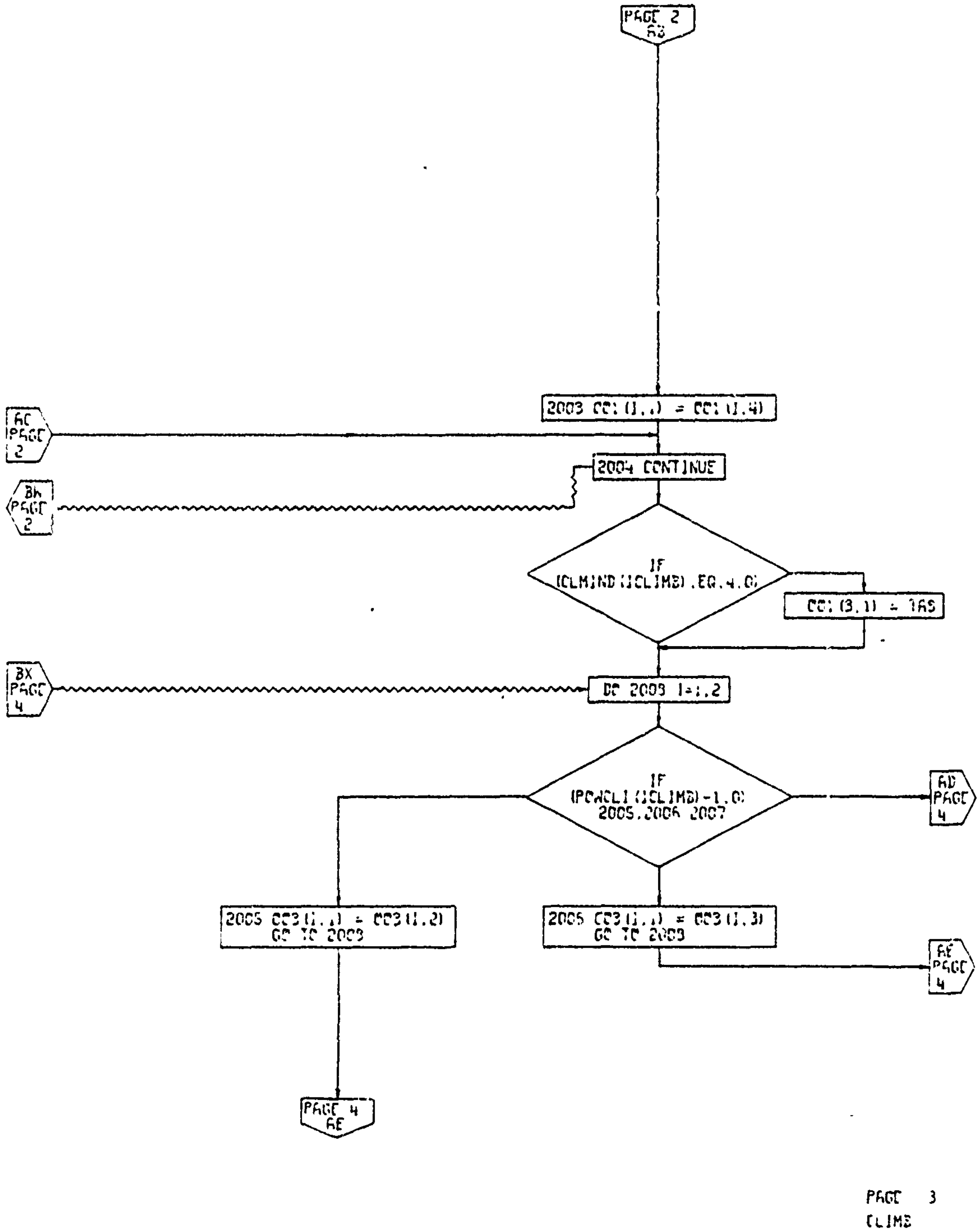


Figure 4-49. Climb Subroutine, Flow Chart
(Part 2 of 22)

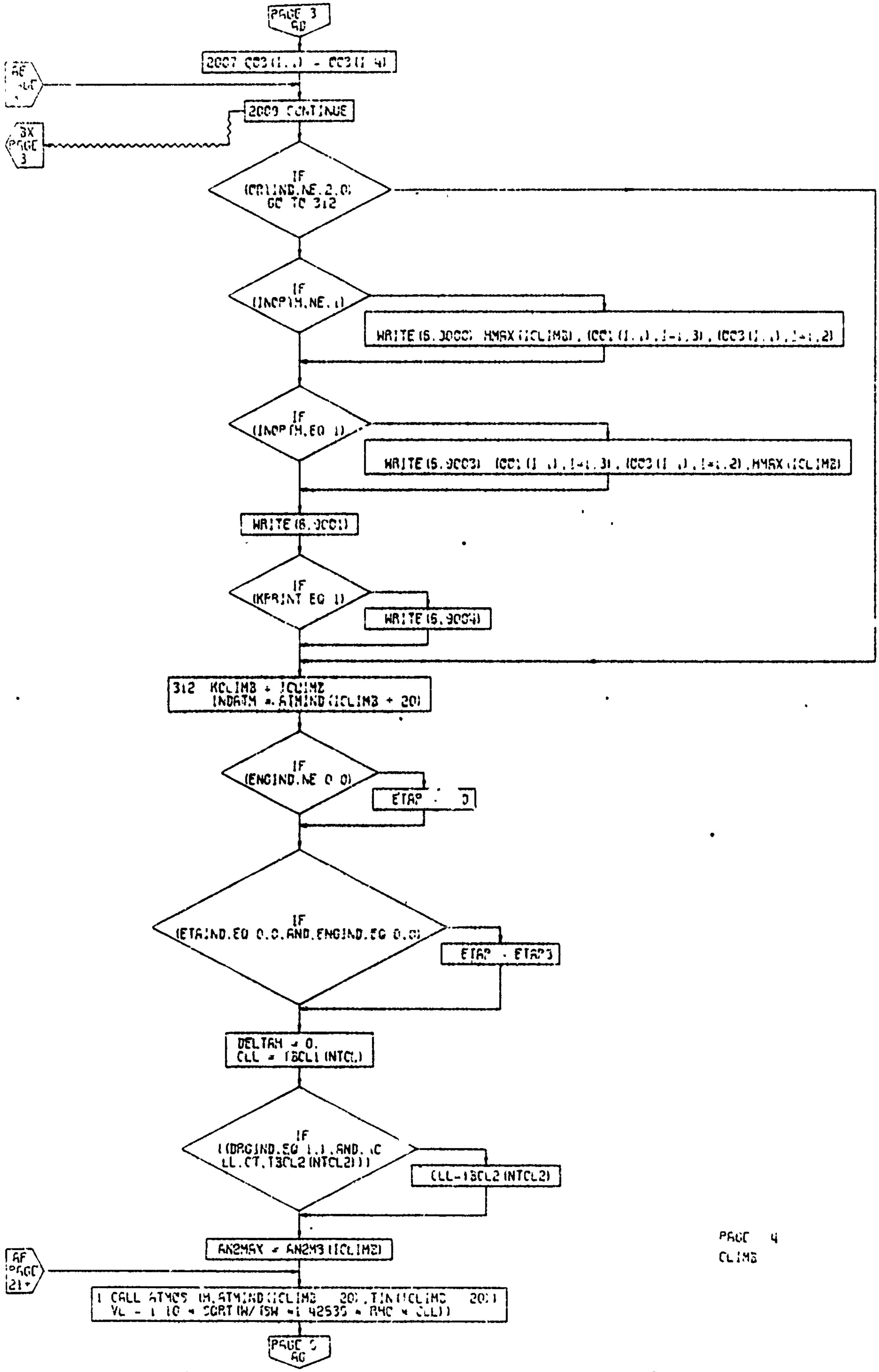


Figure 4-49. Climb Subroutine, Flow Chart
(Part 3 of 22)

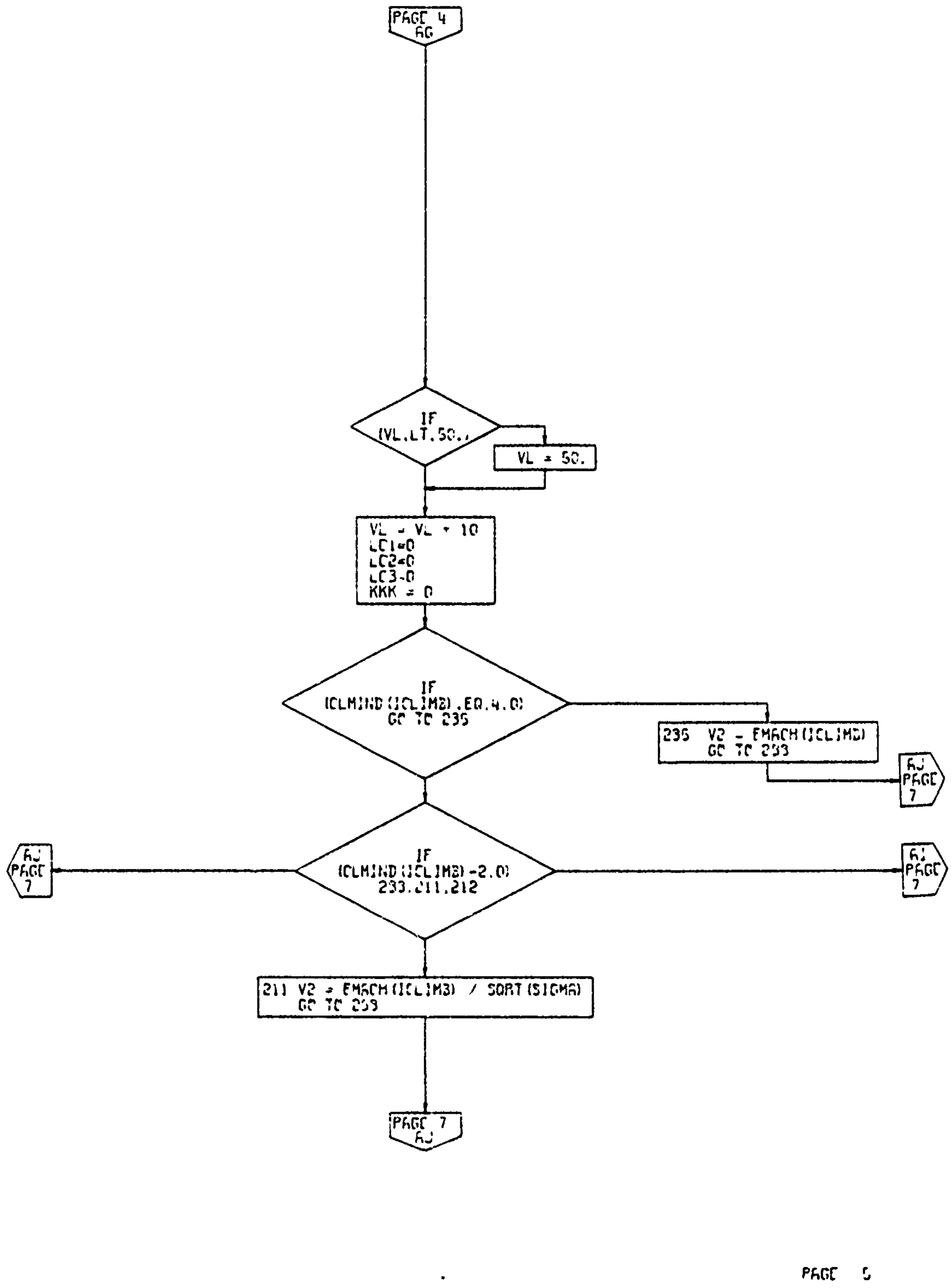


Figure 4-49. Climb Subroutine, Flow Chart
(Part 4 of 22)

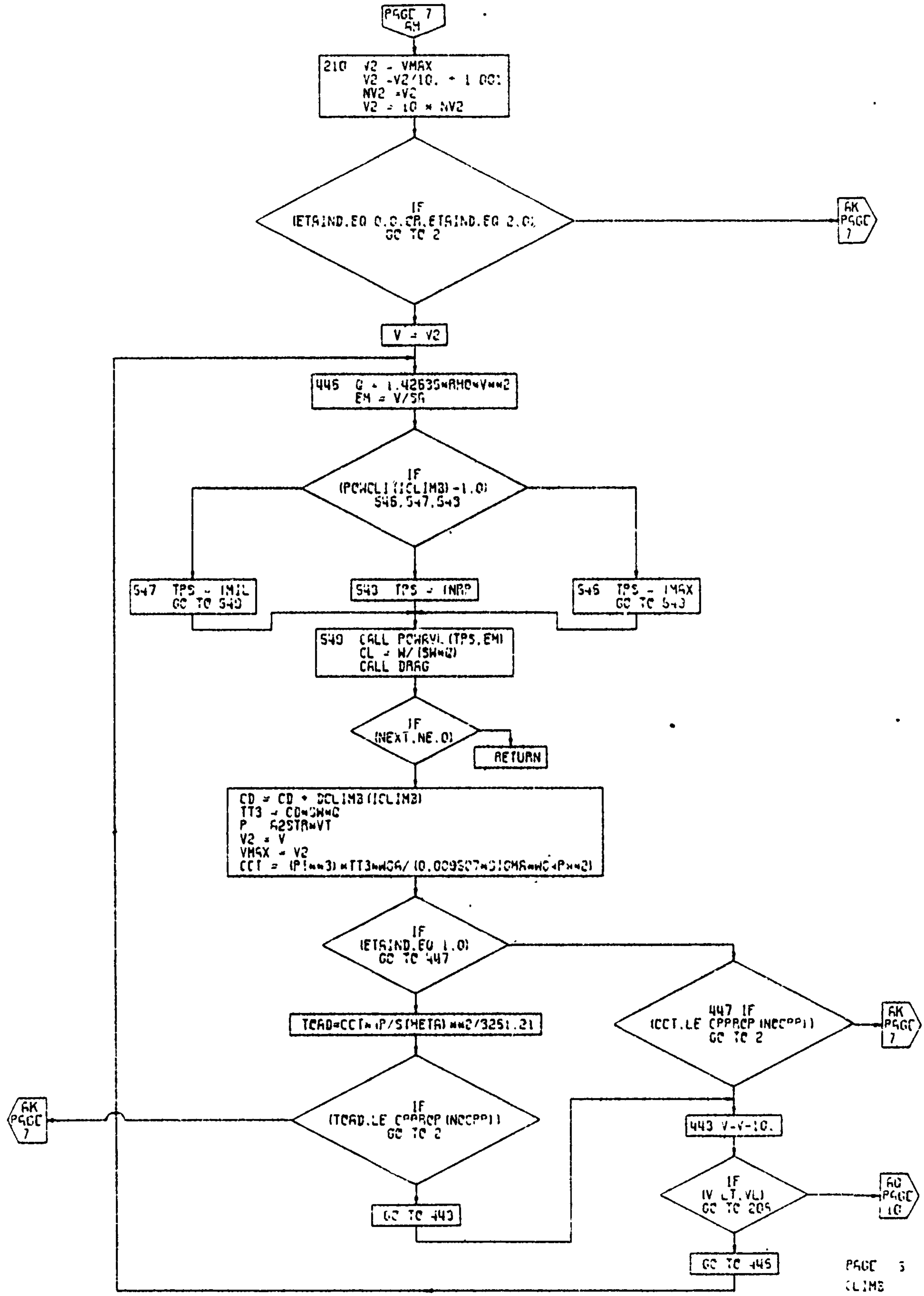


Figure 4-49. Climb Subroutine, Flow Chart
(Part 5 of 22)

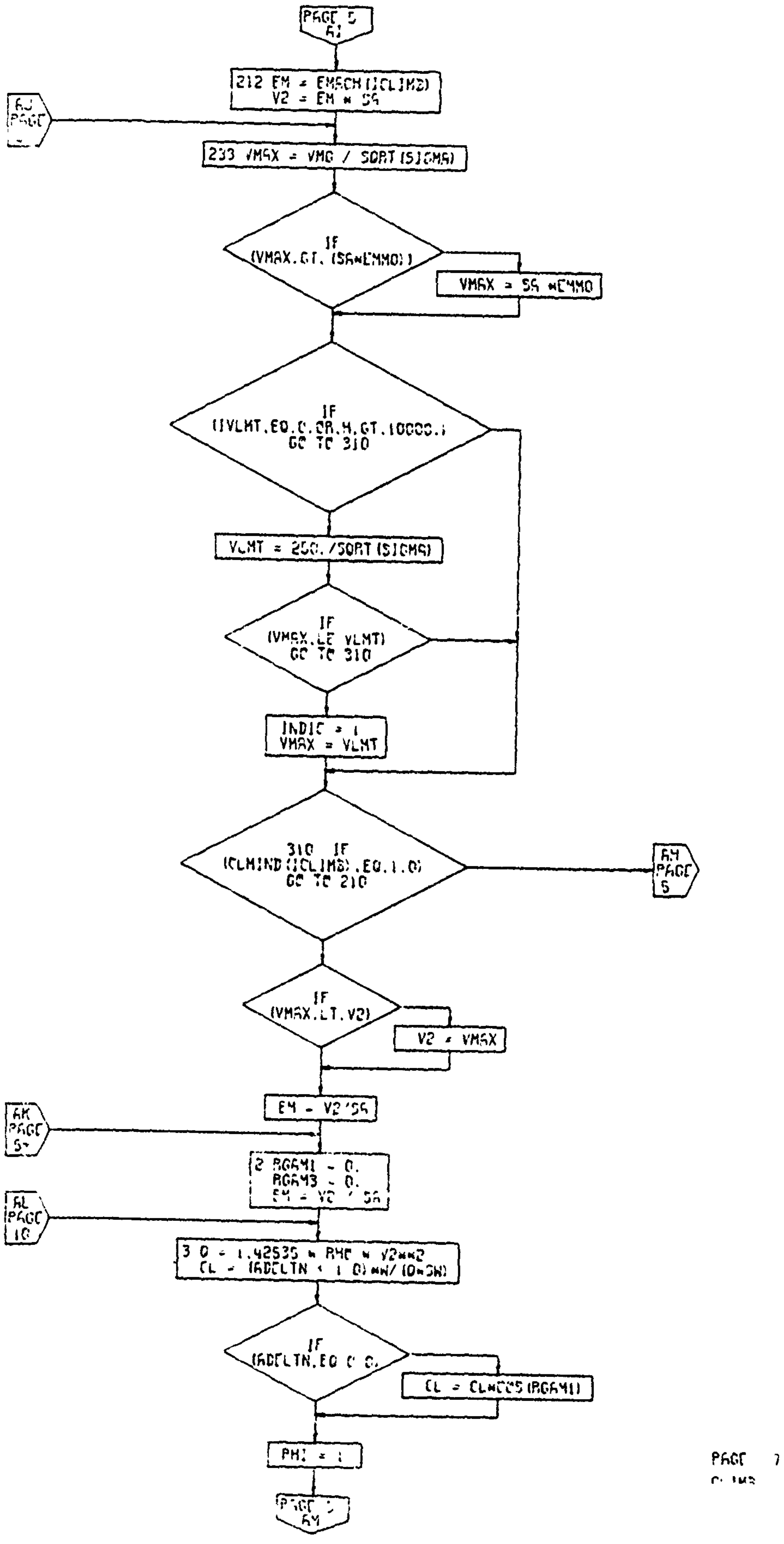


Figure 4-49. Climb Subroutine, Flow Chart
(Part 6 of 22)

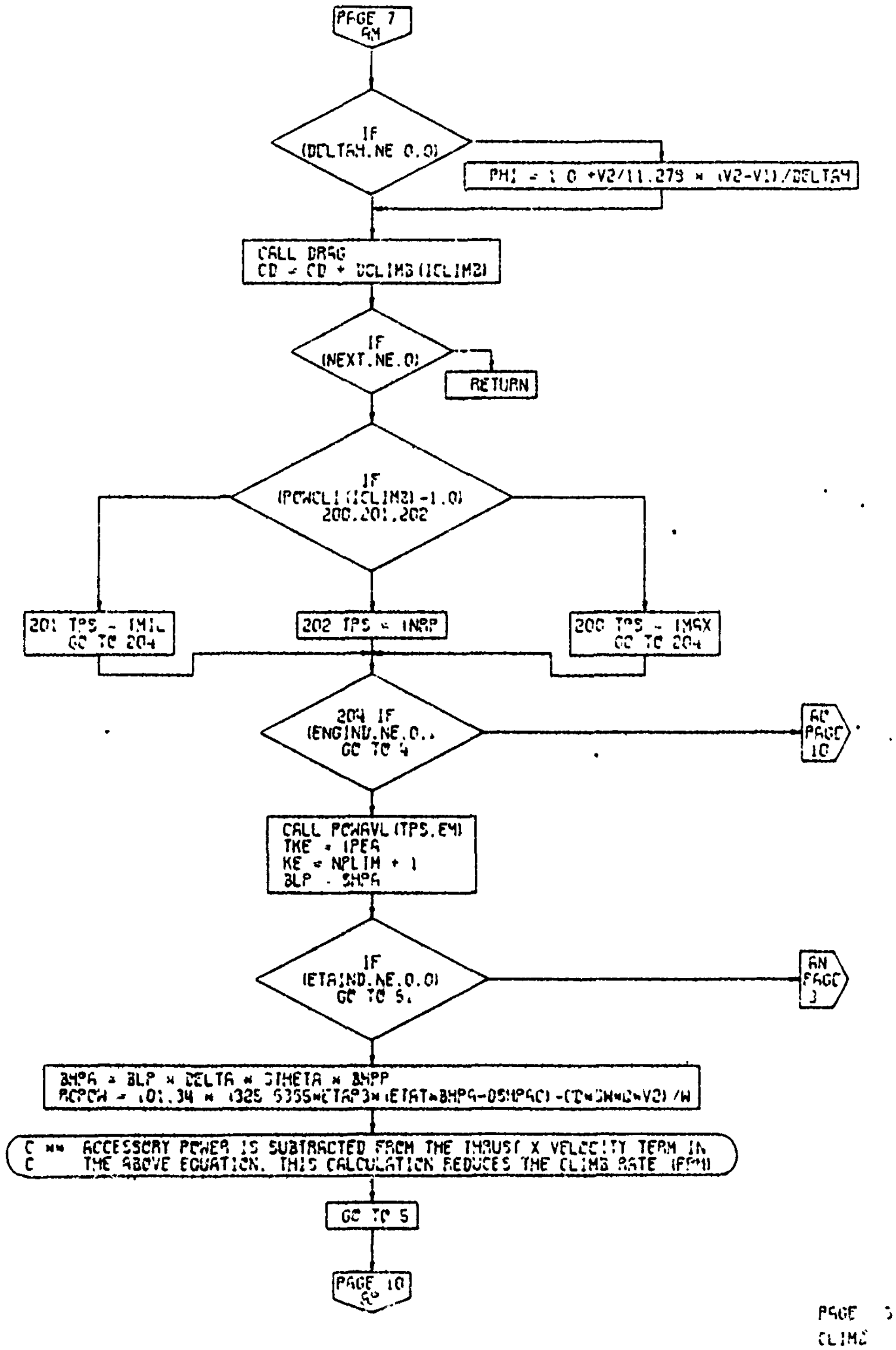
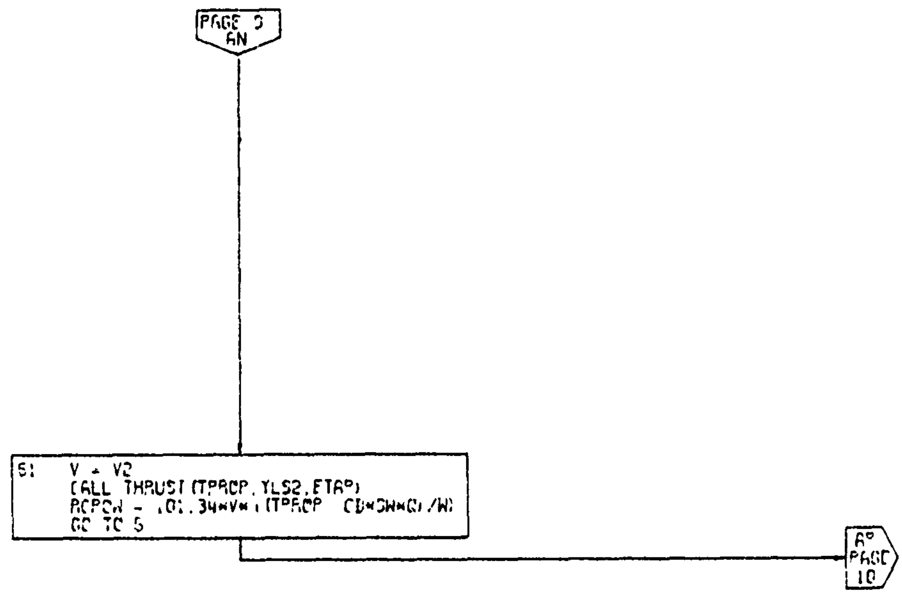


Figure 4-49. Climb Subroutine, Flow Chart (Part 7 of 22)



PAGE 9
CLIMB

Figure 4-49. Climb Subroutine, Flow Chart
(Part 8 of 22)

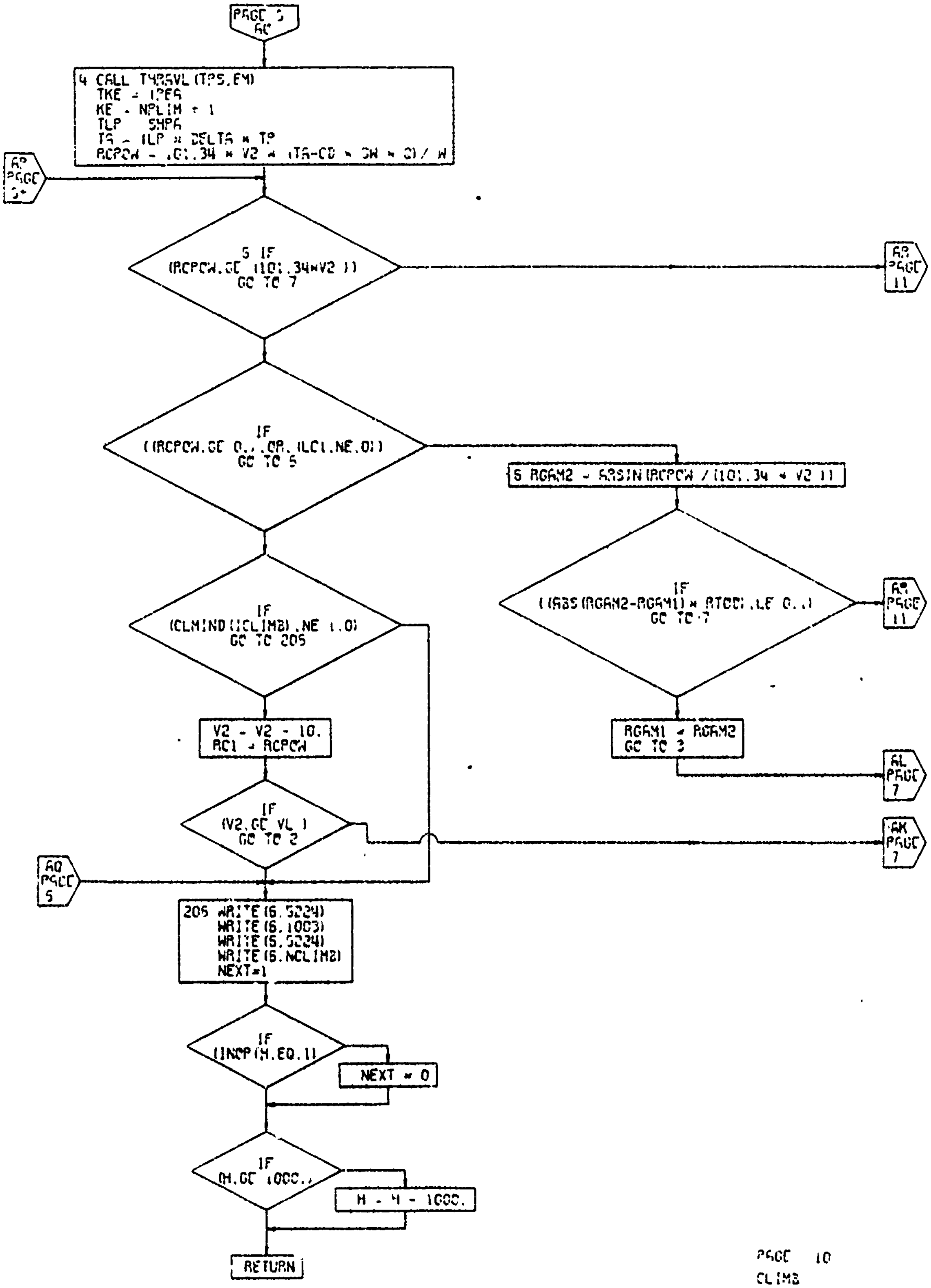


Figure 4-49. Climb Subroutine, Flow Chart
(Part 9 of 22)

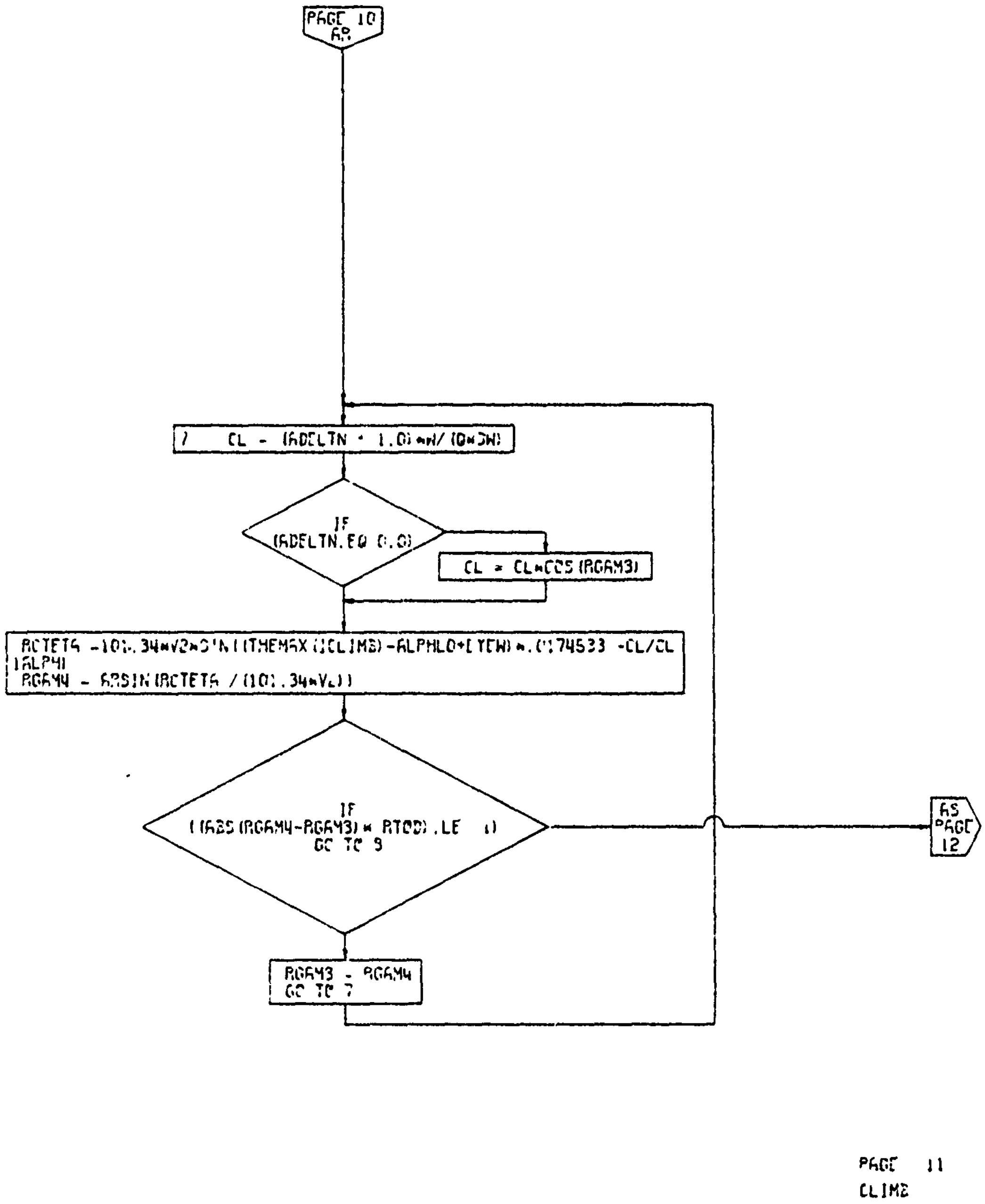


Figure 4-49. Climb Subroutine, Flow Chart
(Part 10 of 22)

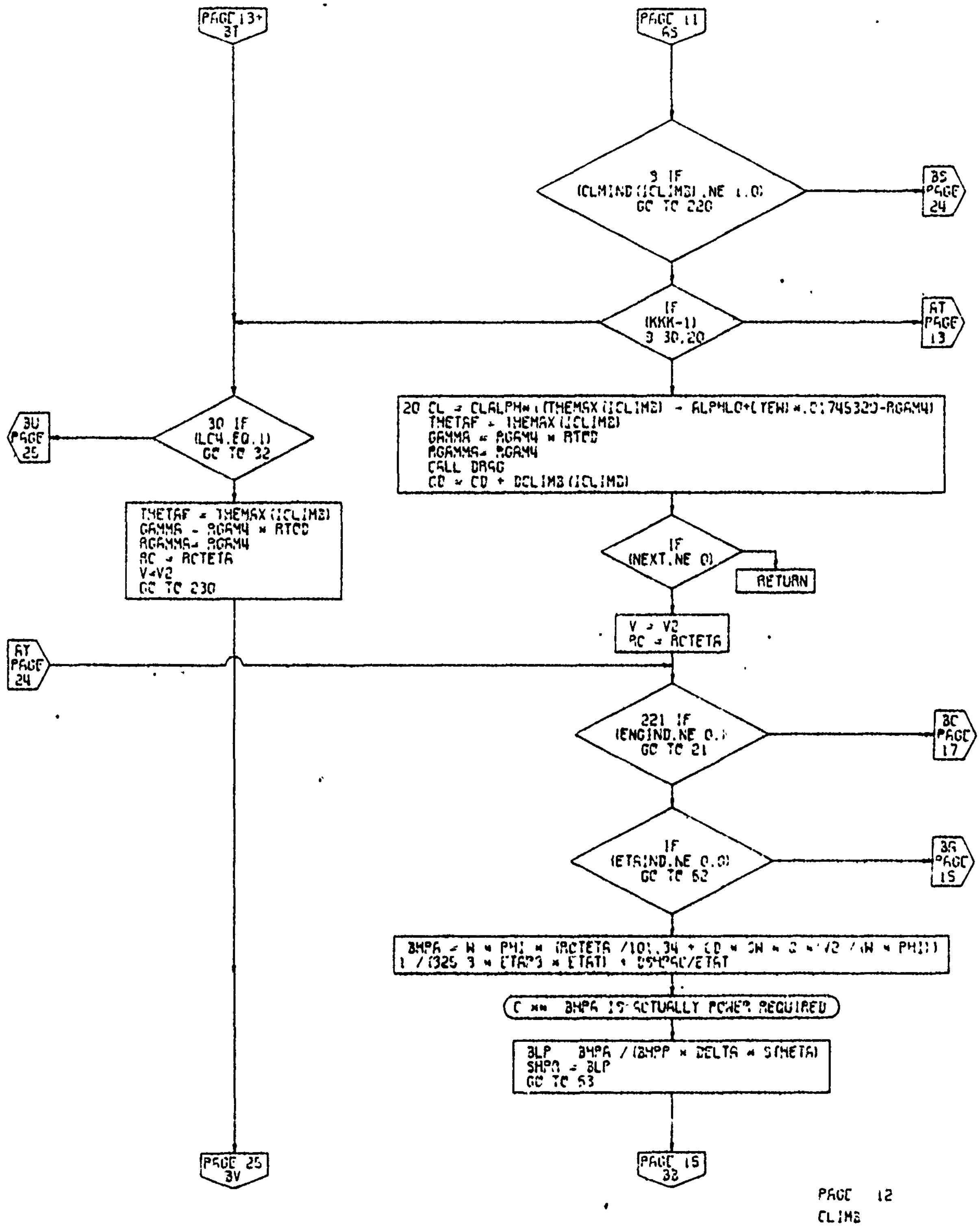


Figure 4-49. Climb Subroutine, Flow Chart
(Part 11 of 22)

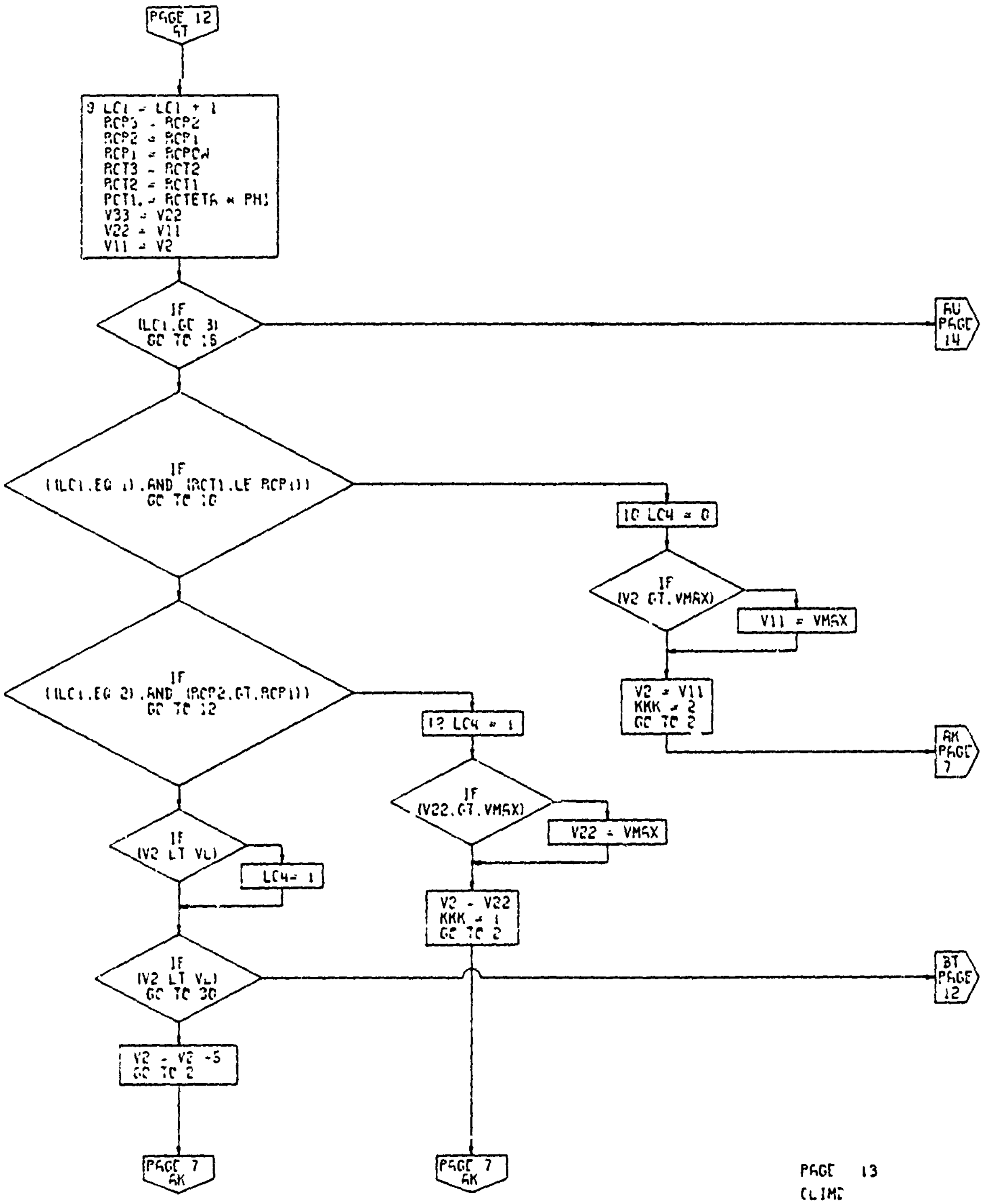


Figure 4-49. Climb Subroutine, Flow Chart
(Part 12 of 22)

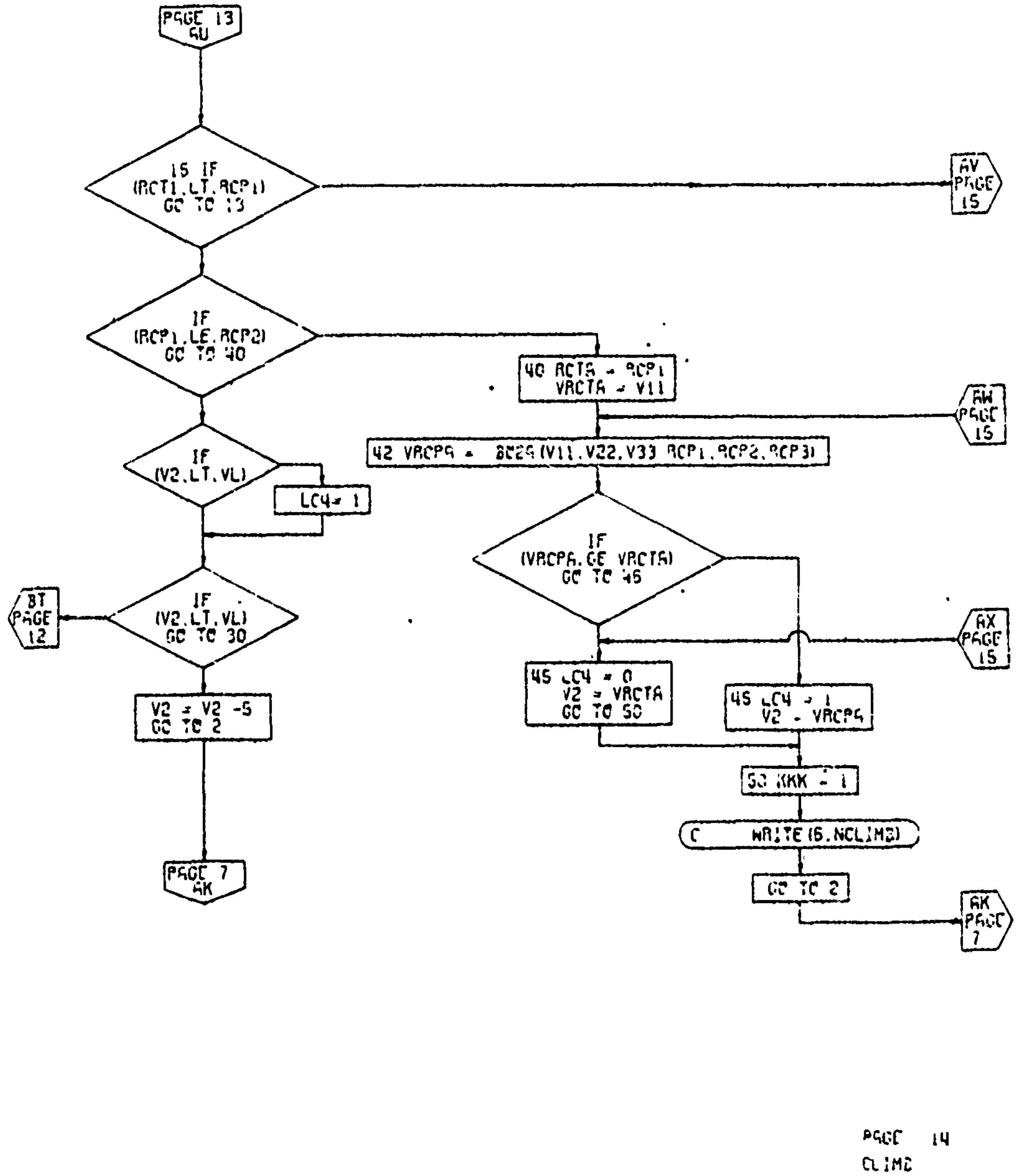
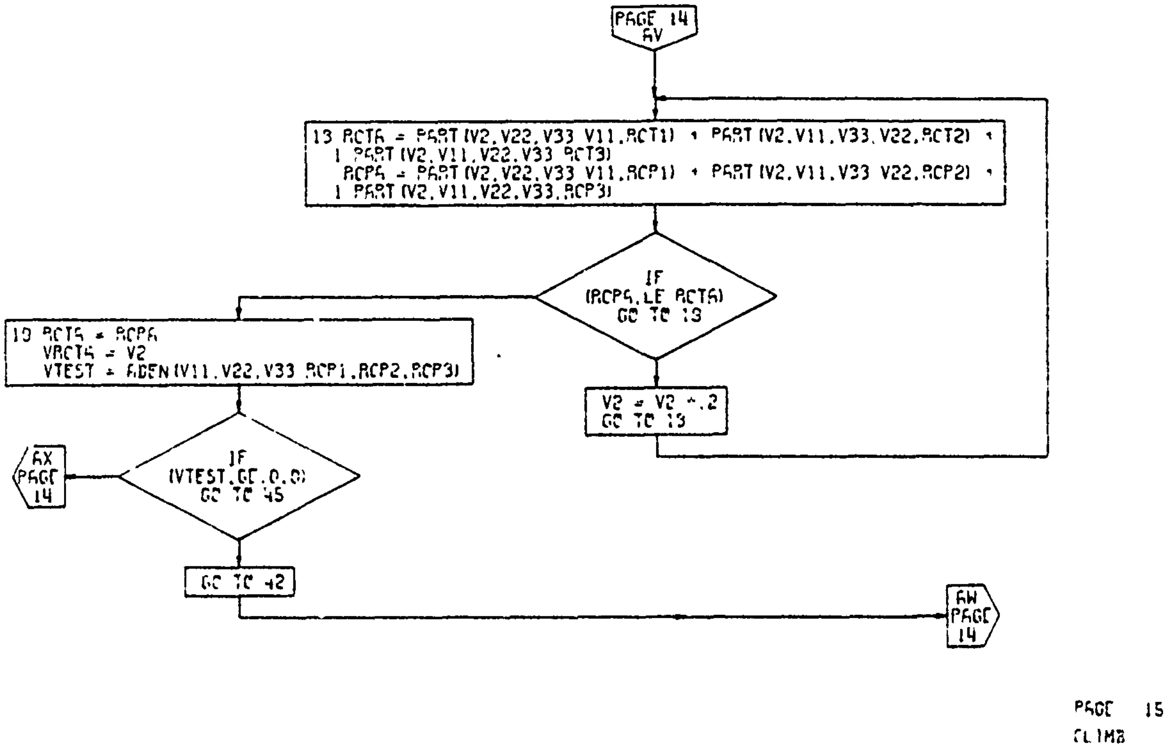


Figure 4-49. Climb Subroutine, Flow Chart
(Part 13 of 22)



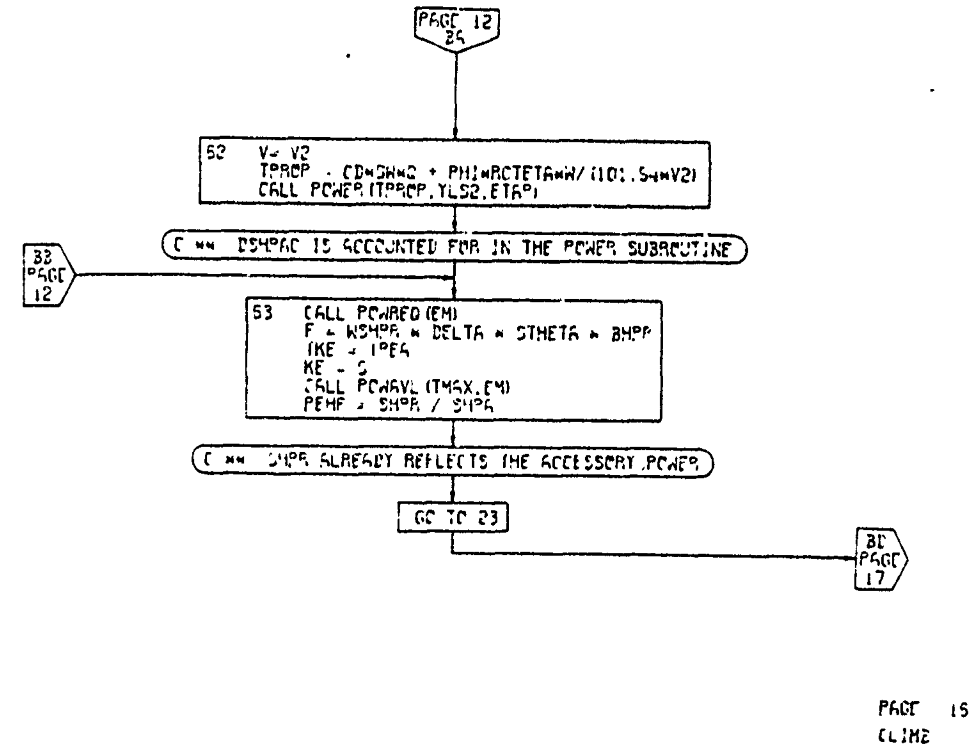


Figure 4-49. Climb Subroutine, Flow Chart
(Part 14 of 22)

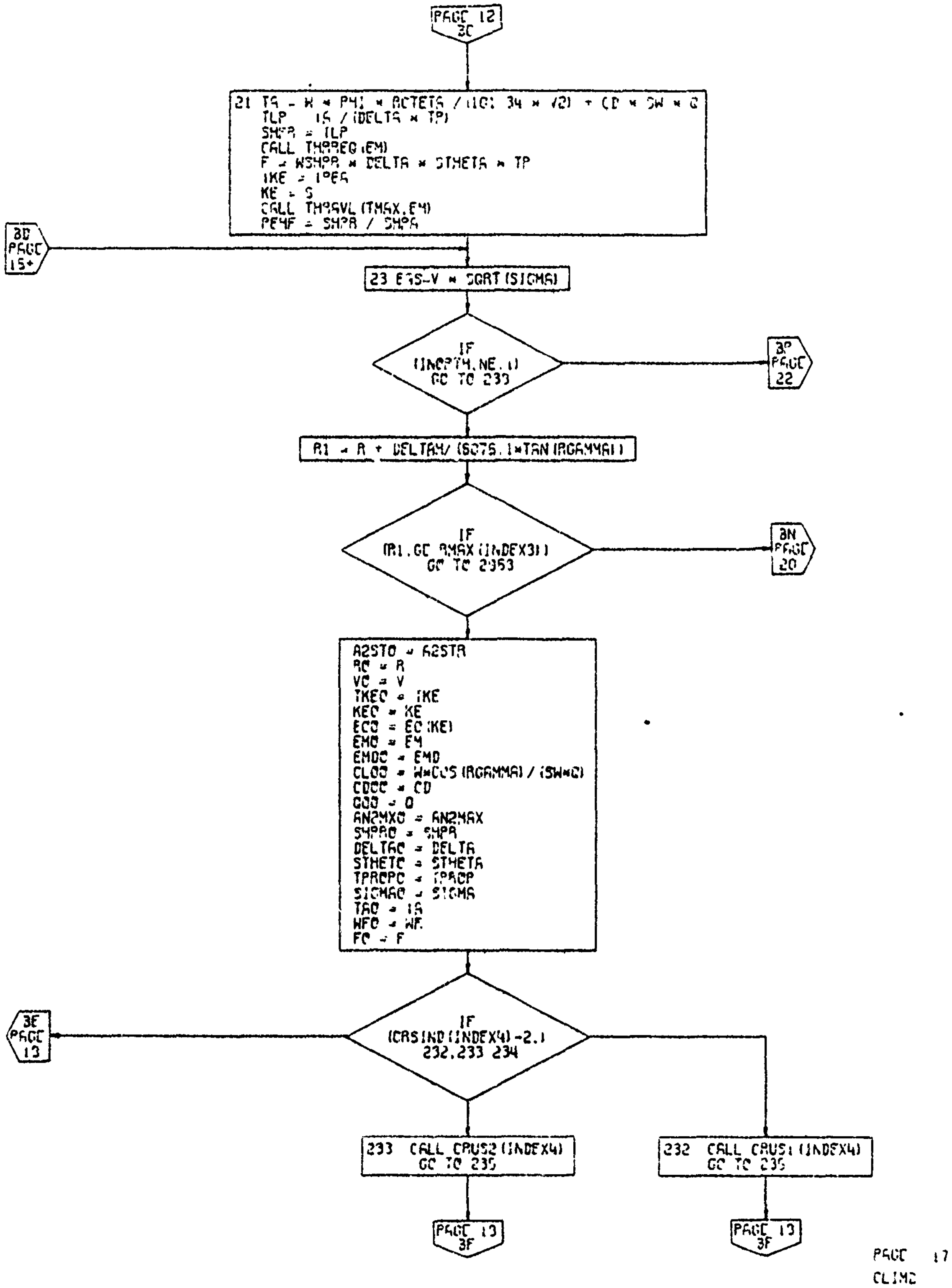


Figure 4-49. Climb Subroutine, Flow Chart (Part 15 of 22)

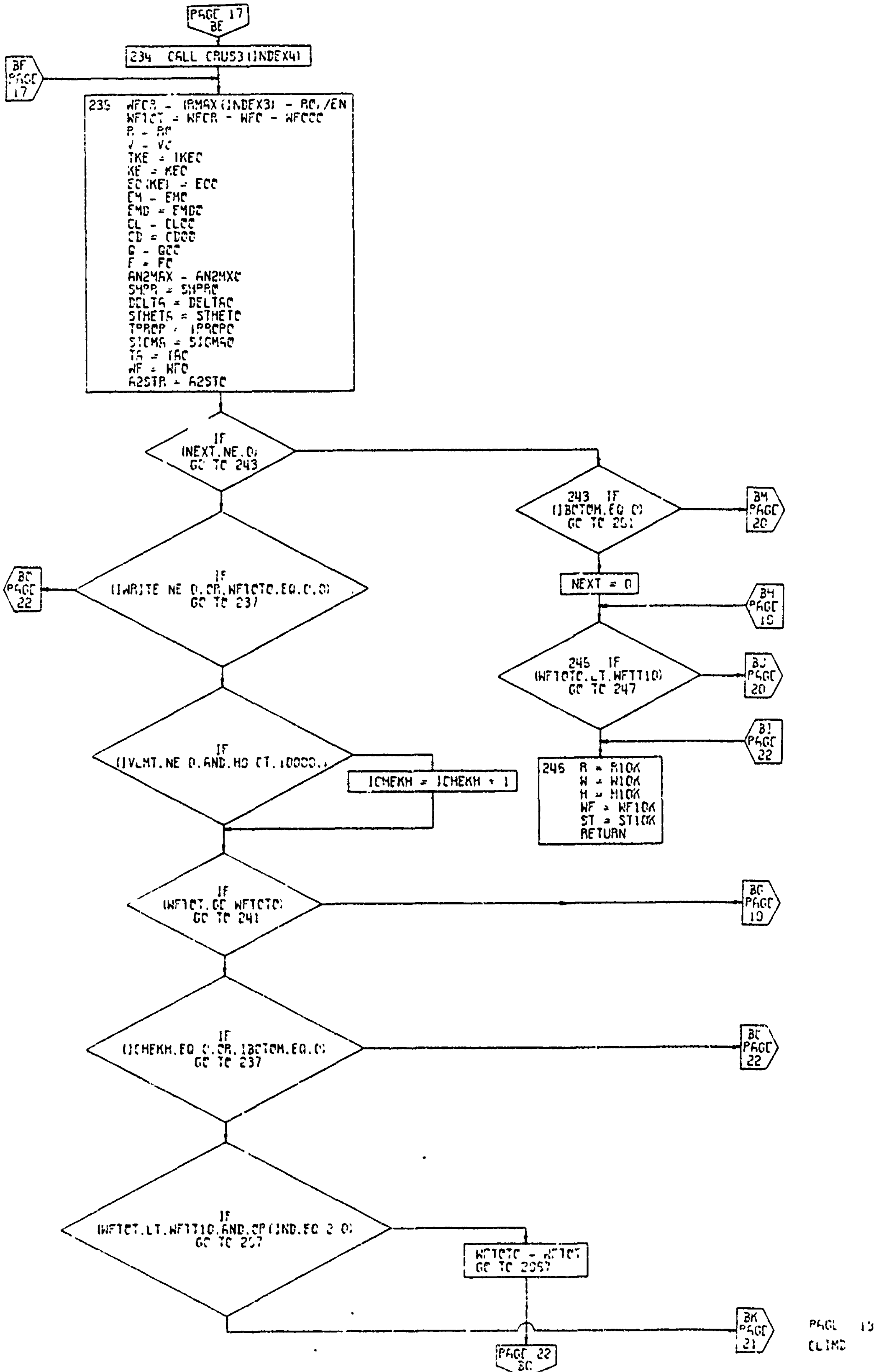


Figure 4-49. Climb Subroutine, Flow Chart
(Part 18 of 22)

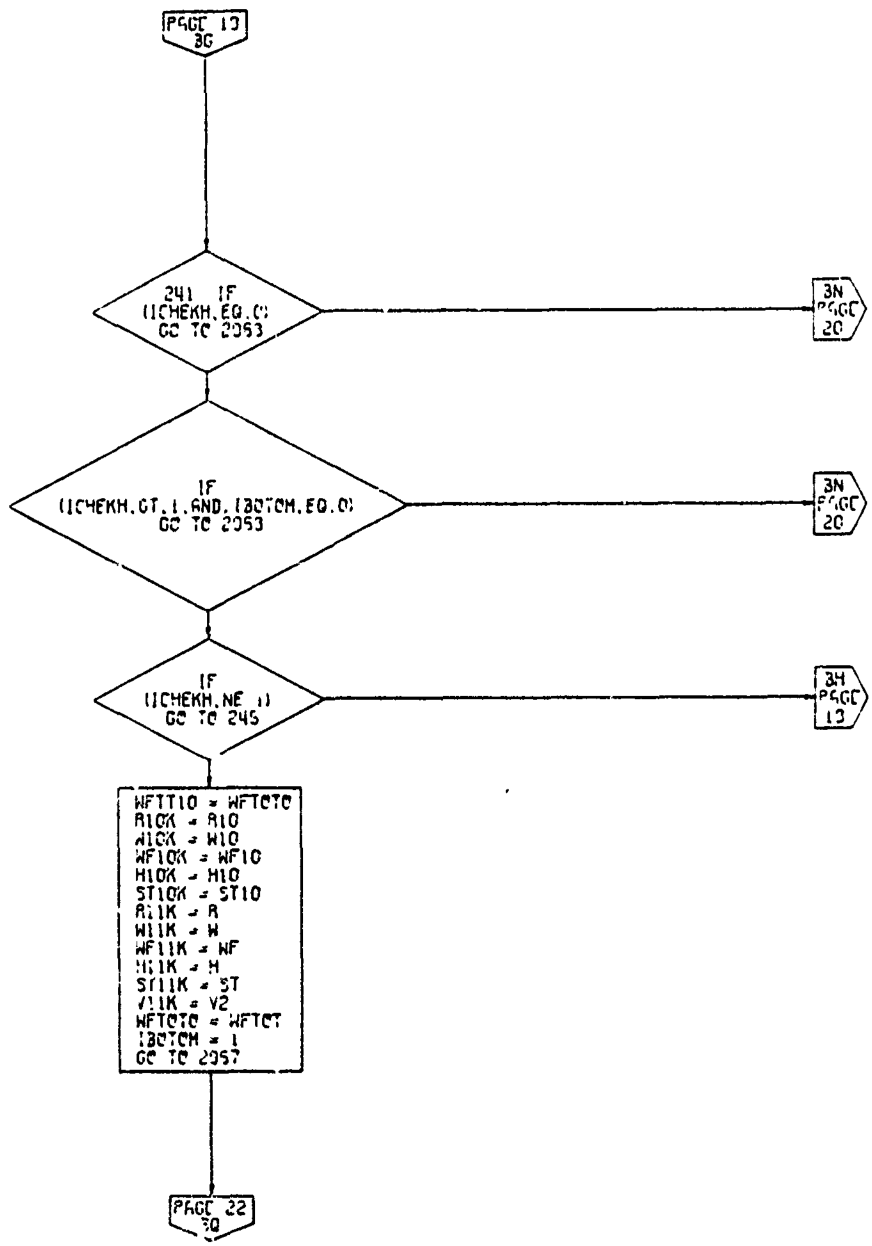
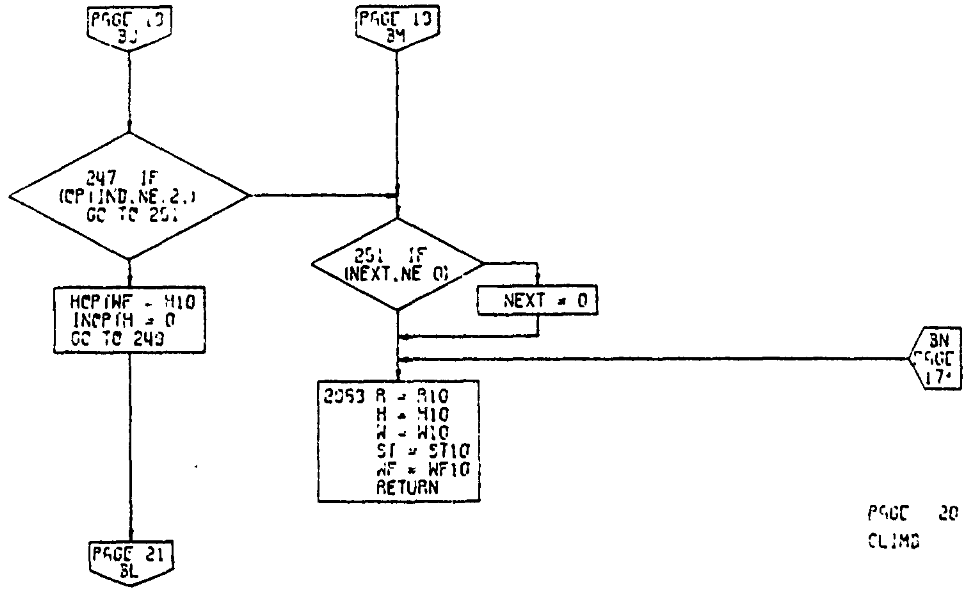


Figure 4-49. Climb Subroutine, Flow Chart
(Part 17 of 22)



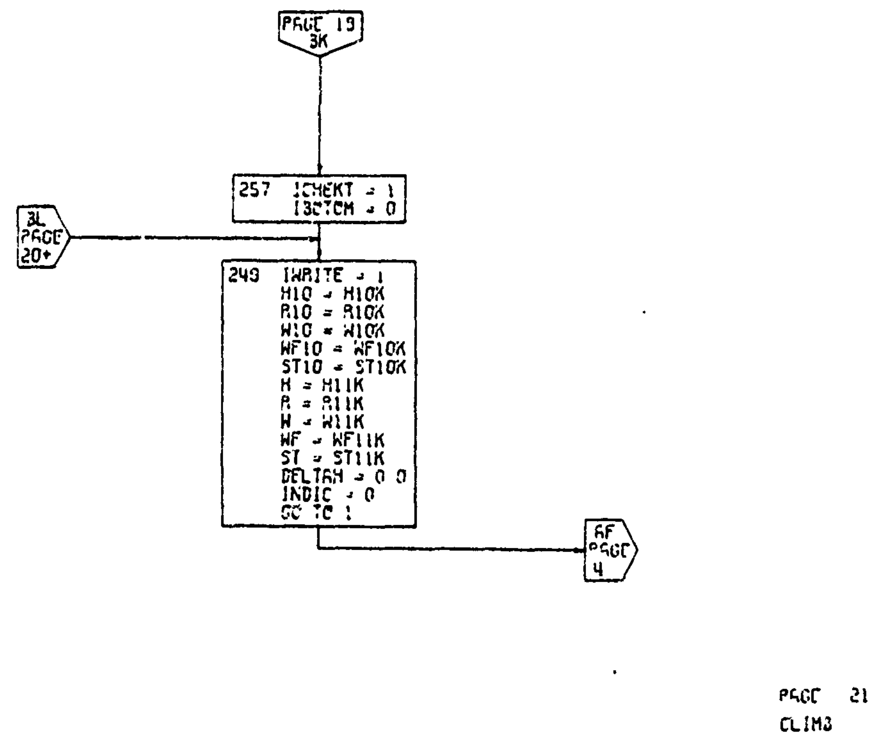
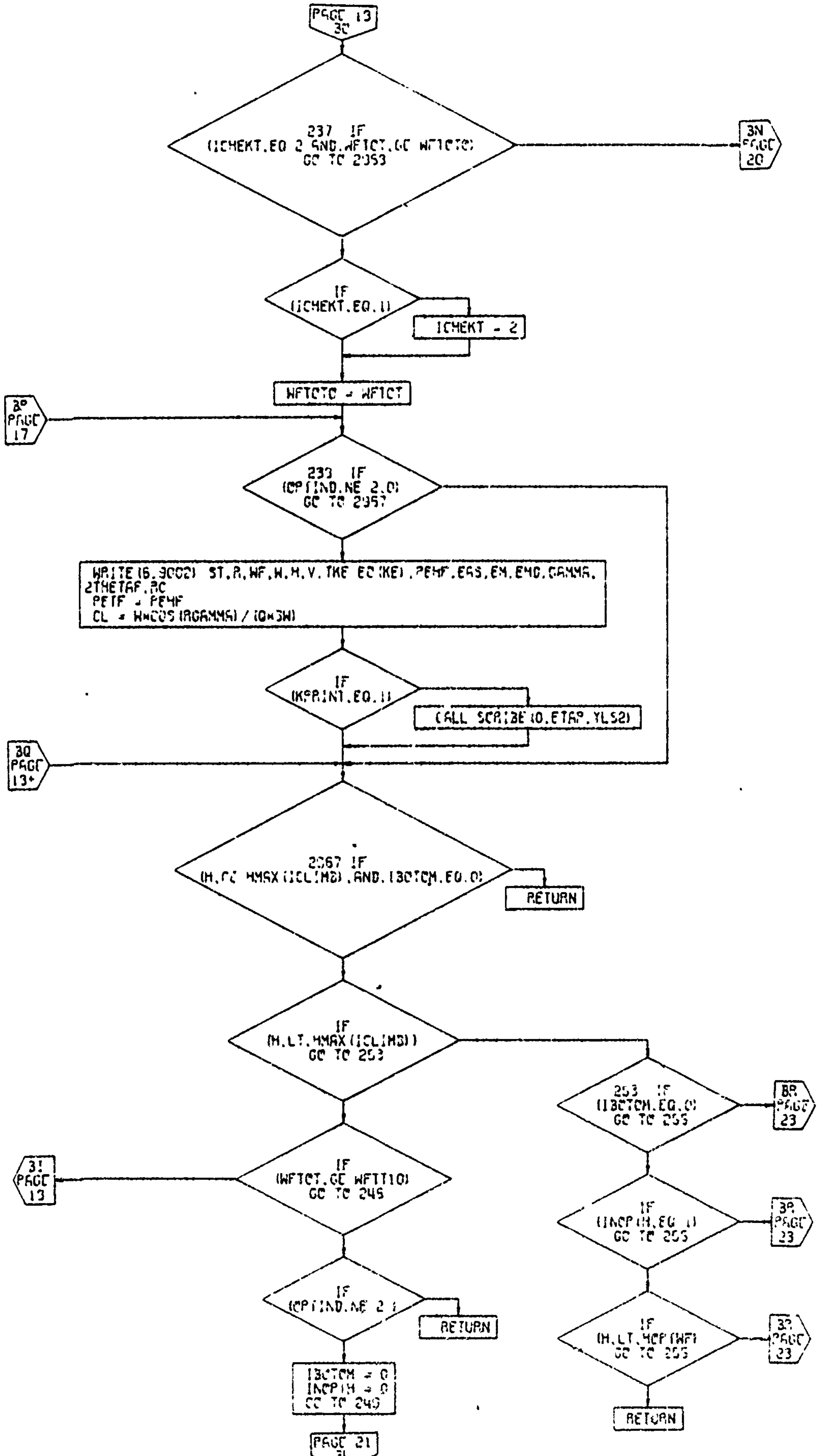


Figure 4-49. Climb Subroutine, Flow Chart
(Part 18 of 22)



PAGE 13 3C
237 IF (ICHEKT.EQ.2.AND.WFTOT.GE.WFTOTO) GO TO 2353
3N PAGE 20
IF (ICHEKT.EQ.1)
ICHEKT = 2
WFTOTO = WFTOT
3P PAGE 17
233 IF (OPTIND.NE.2.0) GO TO 2357
WRITE(6,9002) ST,R,WF,W,H,V,TKE,EO(KE),PEHF,EAS,EM,EMD,GAMMA,
2THETAF,RC
PETF = PEHF
CL = W*COS(RGAMMA)/(Q*SW)
IF (KPRINT.EQ.1)
CALL SCRIBE(0,ETAP,YLS2)
3Q PAGE 13+
2367 IF (H.GE.HMAX(ICLIMB).AND.IBOTCM.EQ.0)
RETURN
IF (H.LT.HMAX(ICLIMB)) GO TO 253
253 IF (IBOTCM.EQ.0) GO TO 255
3R PAGE 23
IF (WFTOT.GE.WFTT10) GO TO 249
3I PAGE 13
IF (INCPTH.EQ.1) GO TO 255
3R PAGE 23
IF (OPTIND.NE.2)
RETURN
IF (H.LT.HCP(WF)) GO TO 255
3R PAGE 23
IBOTCM = 0
INCPTH = 0
GO TO 249
RETURN
PAGE 21 3L

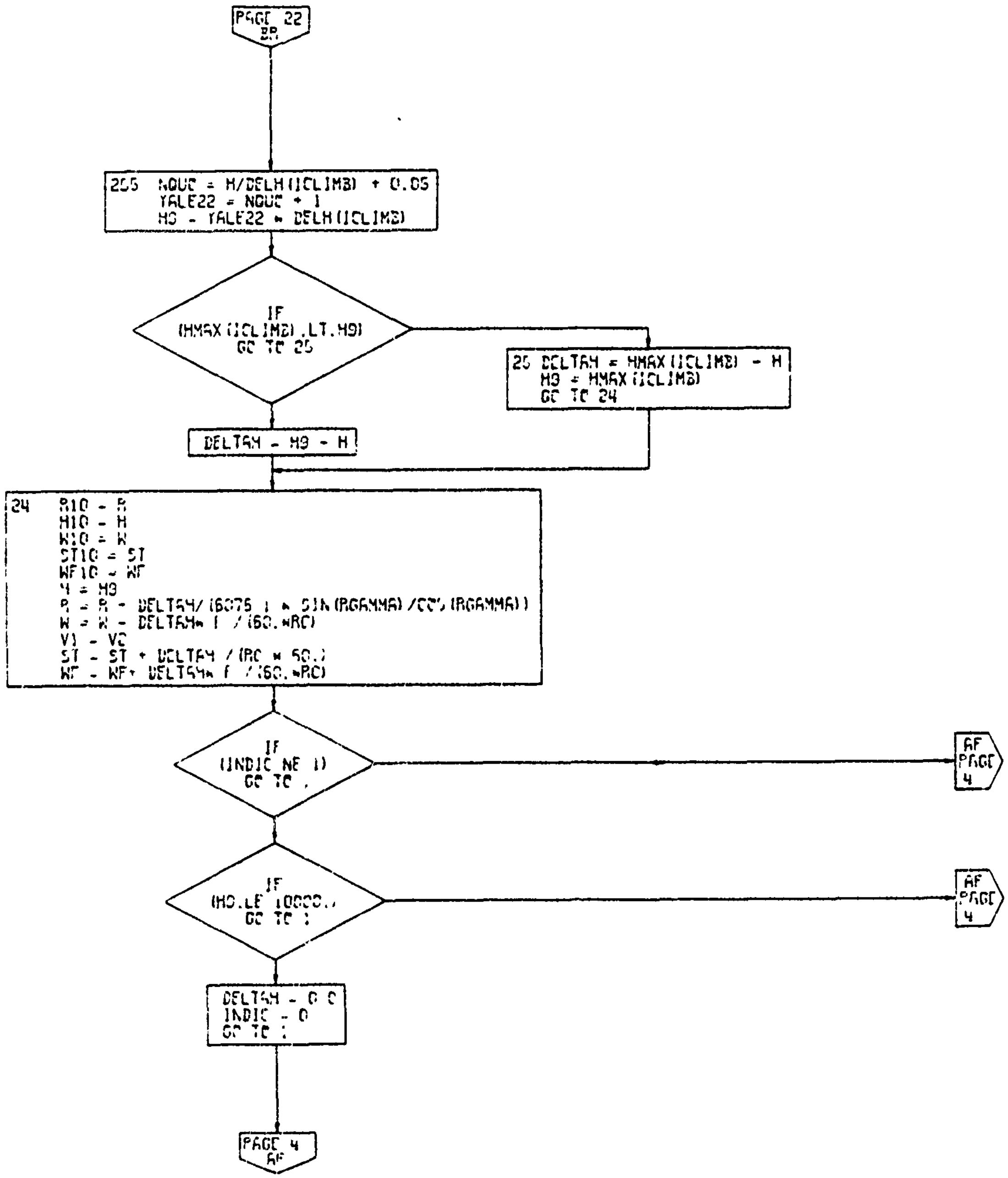


Figure 4-49. Climb Subroutine, Flow Chart
(Part 20 of 22)

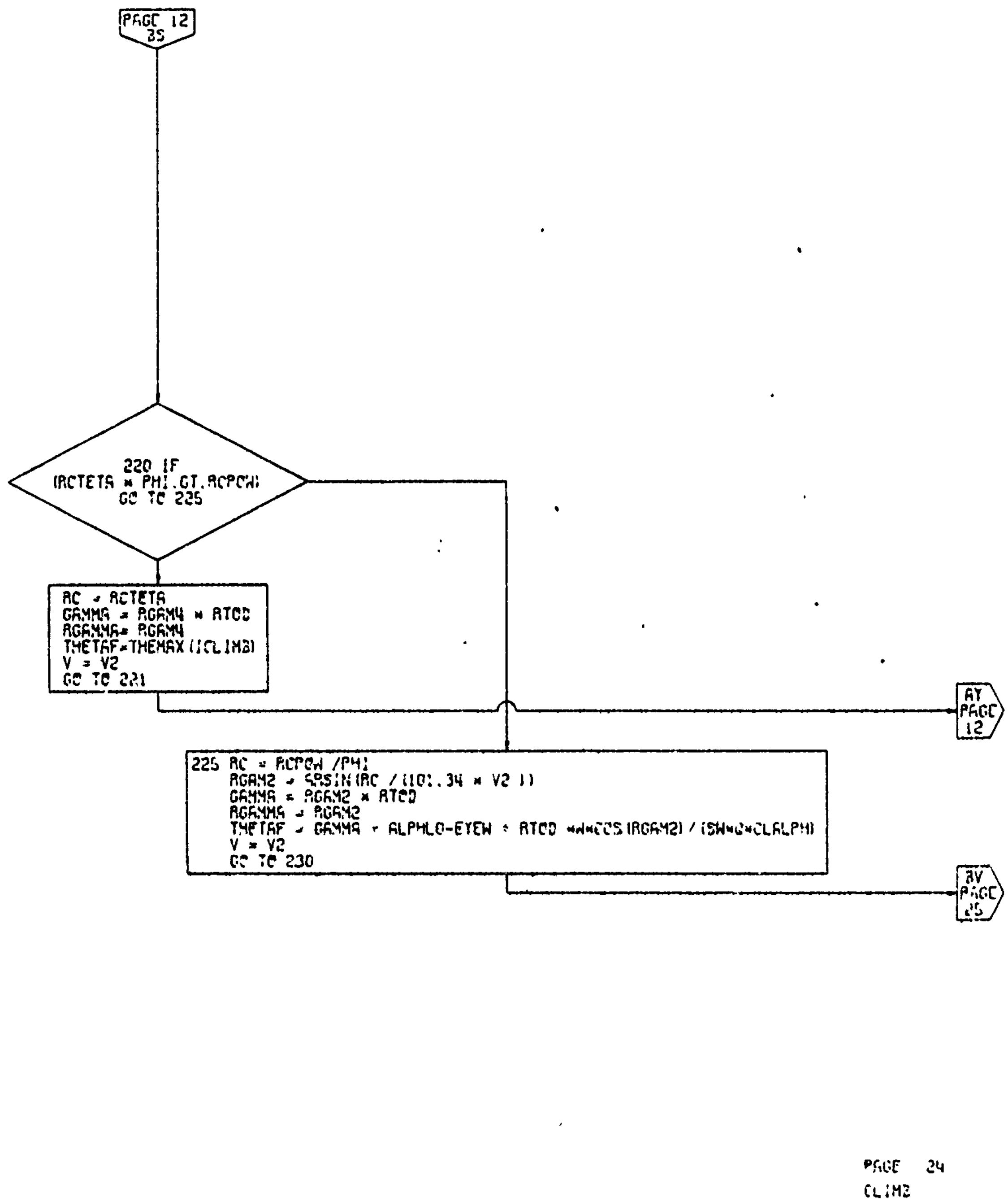


Figure 4-49. Climb Subroutine, Flow Chart
(Part 21 of 22)

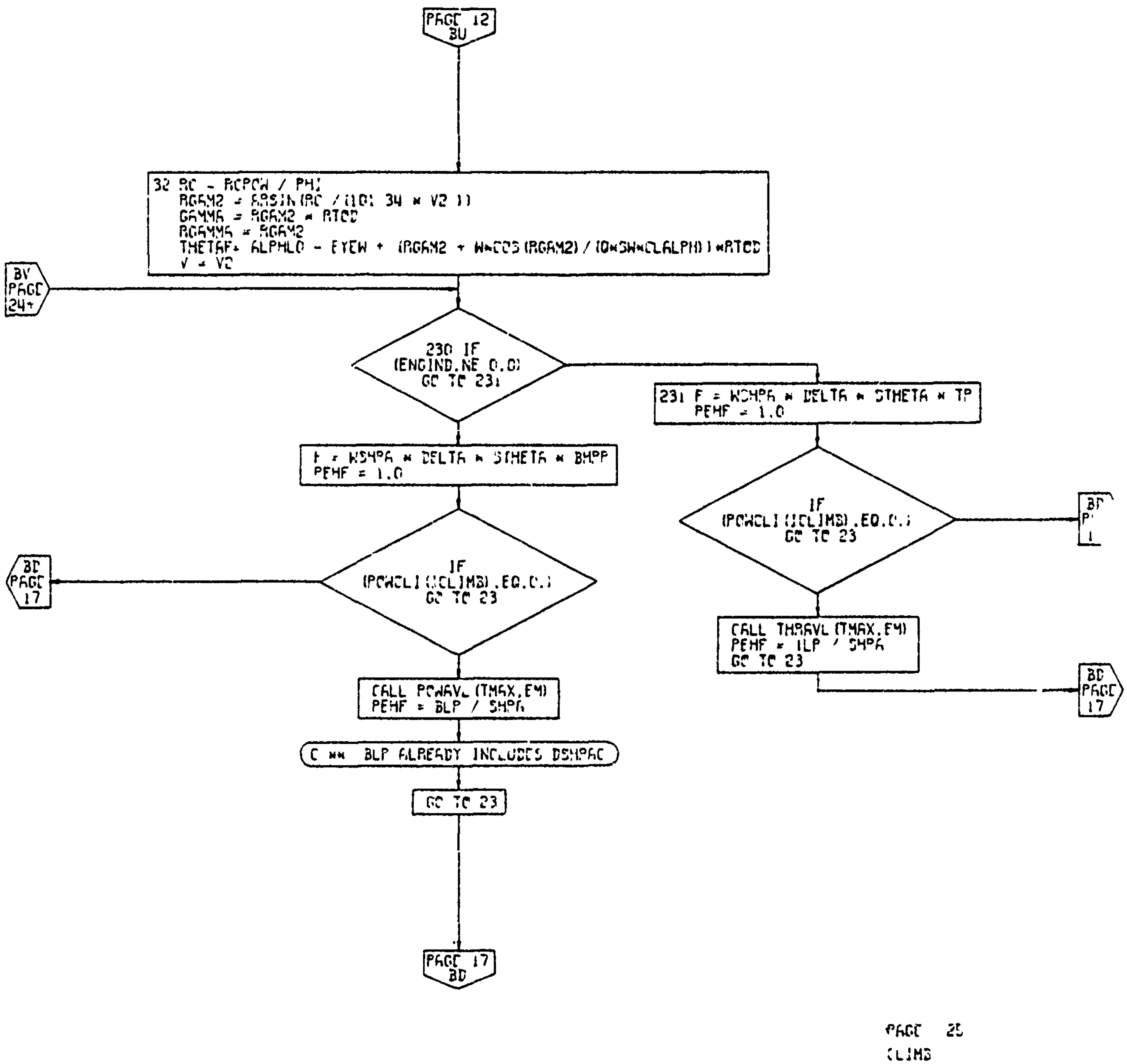


Figure 4-49. Climb Subroutine, Flow Chart
(Part 22 of 22)

4.10.4 Cruise Calculations Subroutine

The fourth performance segment is the calculation of cruise performance. The cruise performance calculation contains six separate options specifying the type of cruise for the aircraft. This option is determined by an input indicator, CRSIND.

CRSIND = 1 - This is a calculation of aircraft cruise performance at a fixed cruise power setting and at a constant altitude, constrained by limiting airspeed and Mach number. This option calculates the true airspeed, Mach number, specific range, and reduction in gross weight during cruise.

CRSIND = 2 - This option will calculate the cruise performance of the aircraft at constant true airspeed, constant altitude, and constrained by cruise power and by limiting airspeed and Mach number. The program will calculate the power setting required, true airspeed, specific range, and corresponding reduction in gross weight of the aircraft during cruise.

CRSIND = 3 - This option calculates the airspeed during cruise required for best specific range, constrained by normal power setting and by limiting airspeed and Mach number. Flight is at constant altitude.

CRSIND = 4 - This option will calculate the "long range cruise" condition - that is, cruise at speed for 99% of best specific range. Flight is constrained by normal power setting, limiting airspeed and Mach number and is at constant altitude.

CRSIND = 5 - This option is a calculation for a cruise-climb at a constant value of W/δ (airplane weight to ambient pressure ratio). The airspeed will be the speed for best specific range.

CRSIND = 6 - This is a calculation for a cruise climb (constant W/δ) at the speed for 99% of best specific range.

Cruise power setting as discussed above is defined by user input to be maximum (POWIND = 0), military (POWIND = 1), or normal (POWIND = 2) engine rating.

This subroutine permits simulation of cruise performance of an aircraft with an arbitrary number of engines shut down. The program user specifies the number of

engines shut down and a corresponding increment in airplane drag coefficient.

The user may also specify a desired value of headwind when CRSIND = 3 through 6.

The input for the subroutine consists of the final range for cruise, the step size (incremental range), number of engines shut down, increment in drag coefficient, atmospheric conditions, required true airspeed (if CRSIND = 2) the headwind (if CRSIND = 3, 4, 5, or 6) and the settings for CRSIND and POWIND. Figure 4-50 is a flow chart of this subroutine.

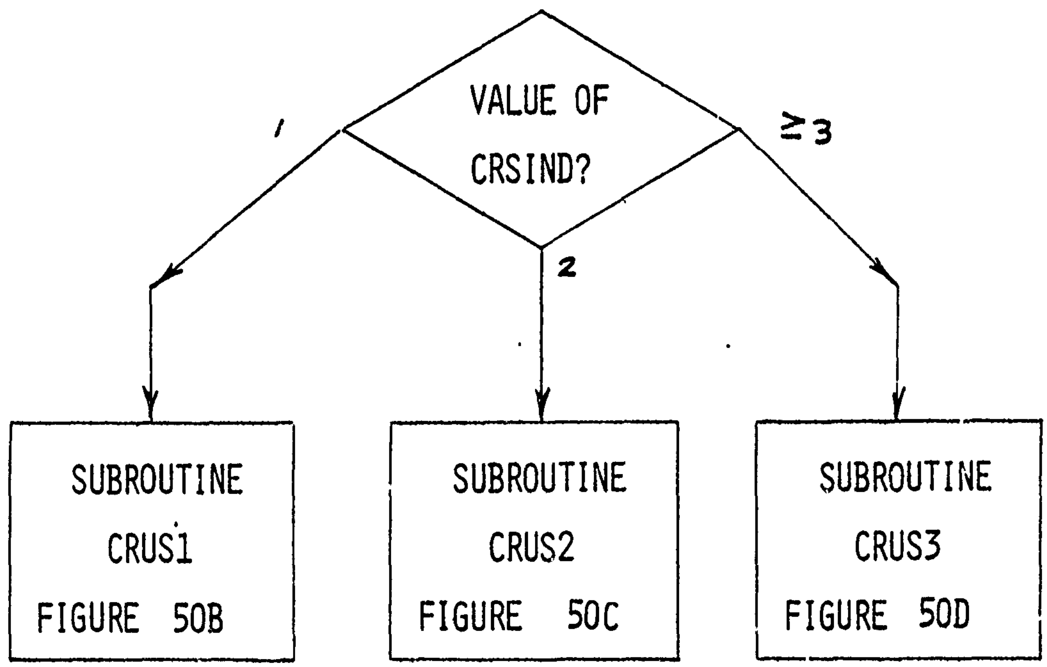


Figure 4-50a. Cruise Calculations Subroutine, Flow Chart.

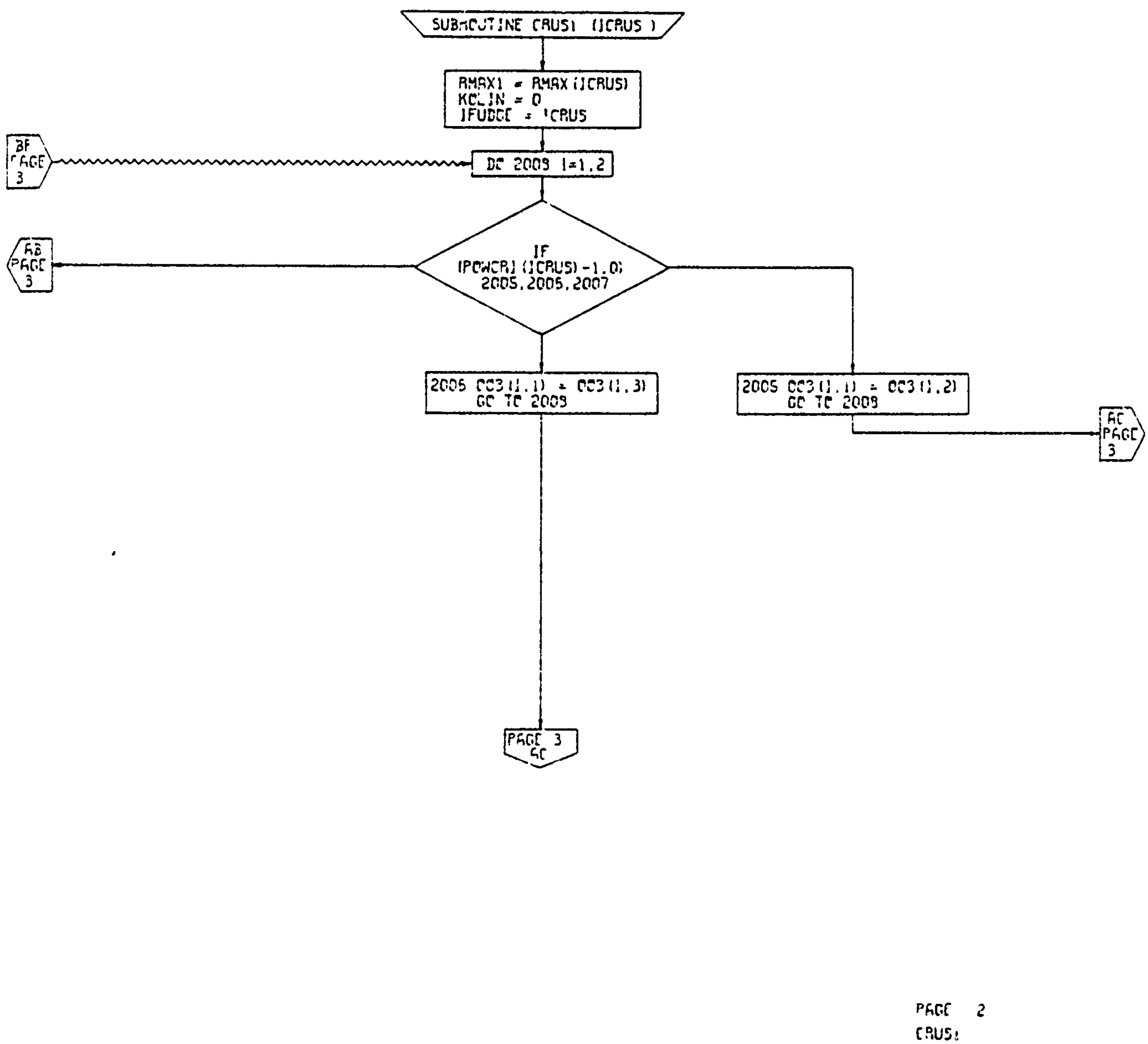


Figure 50B . CRUS1 Calculations Subroutine, Flow Chart (Part 1 of 10)

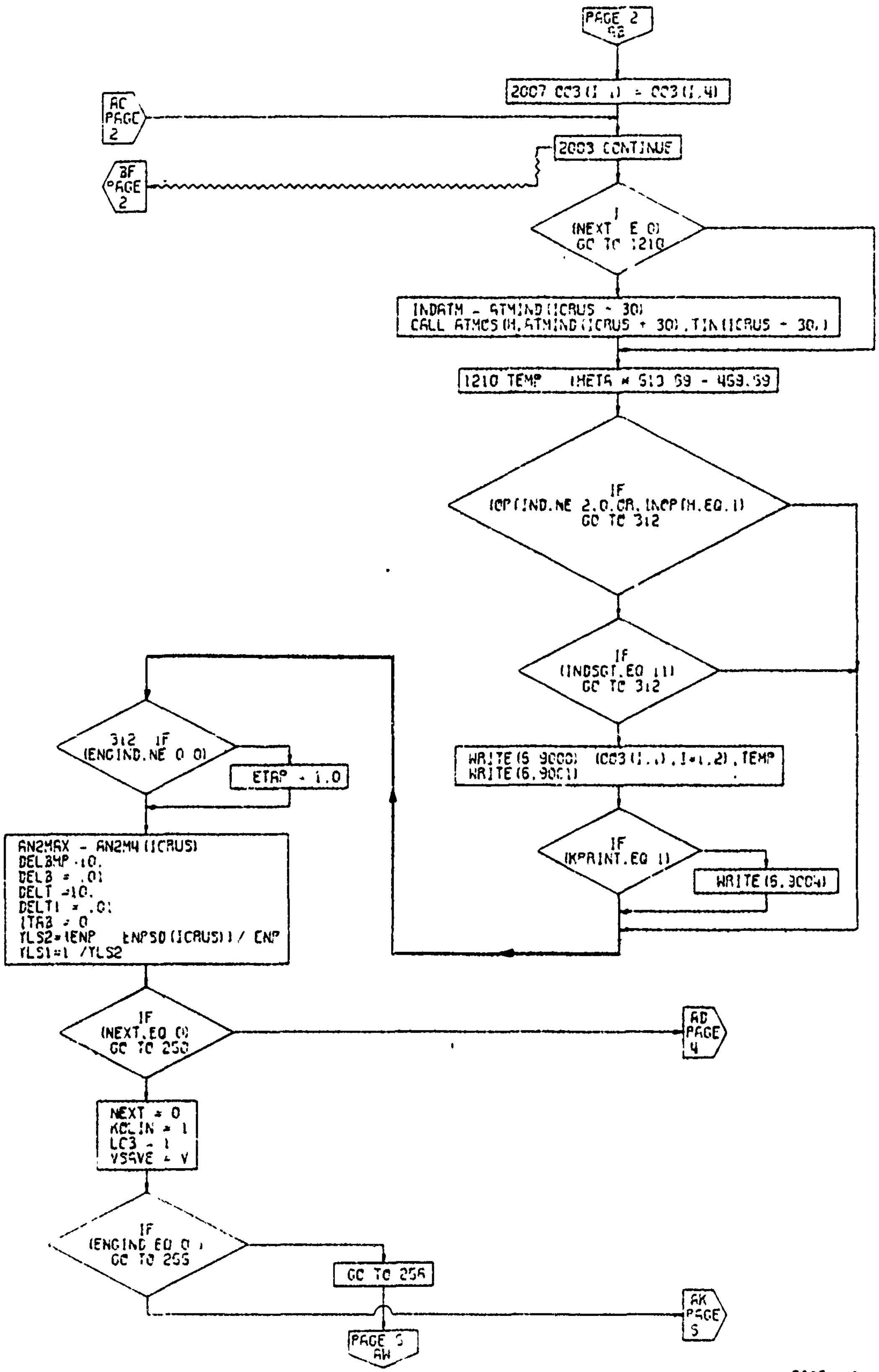


Figure 50B. CRUS1 Calculations Subroutine, Flow Chart (Part 2 of 10)

PAGE 3
CRUS1

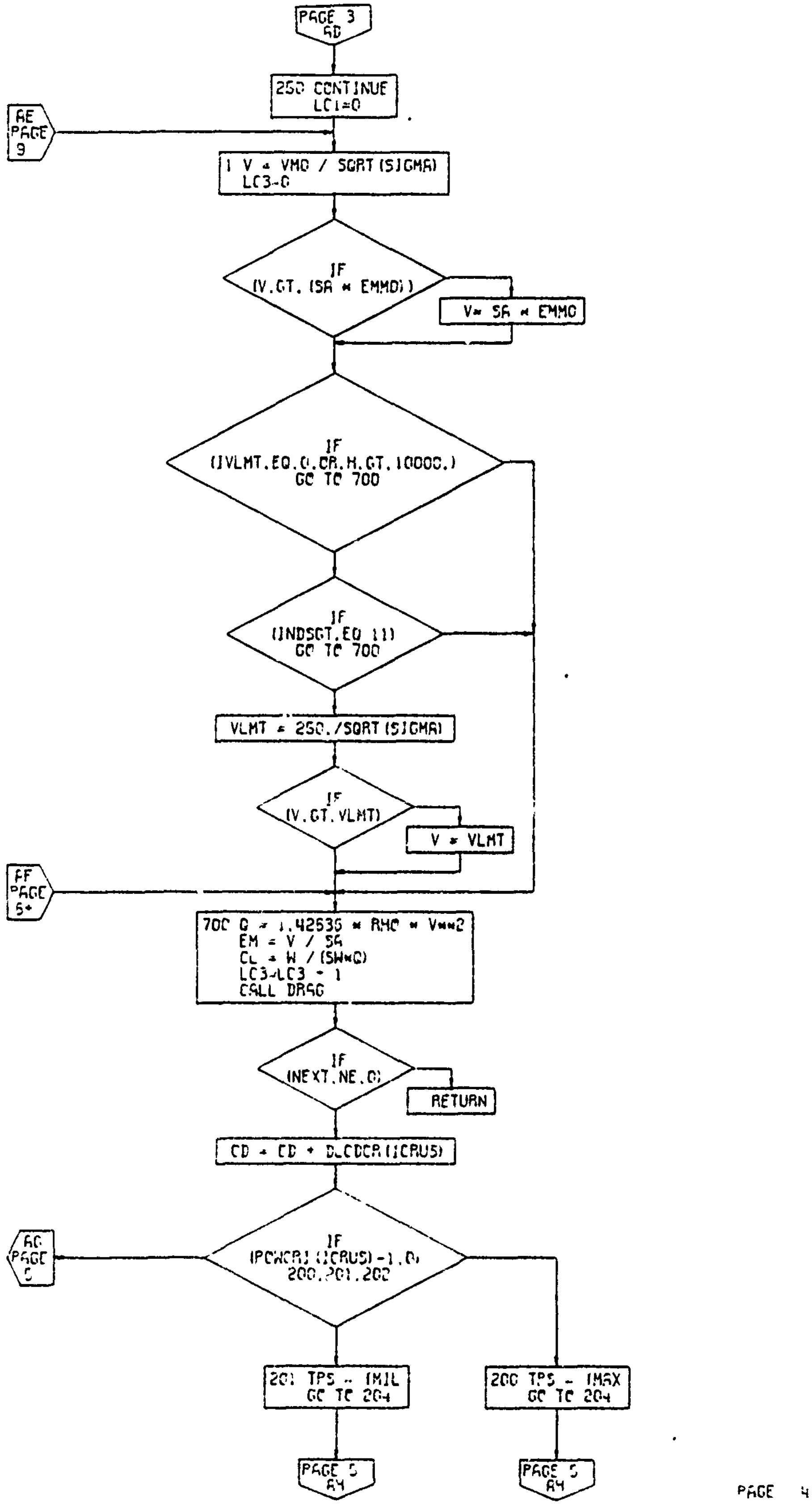


Figure 50B. CRUS1 Calculations Subroutine, Flow Chart (Part 3 of 10)

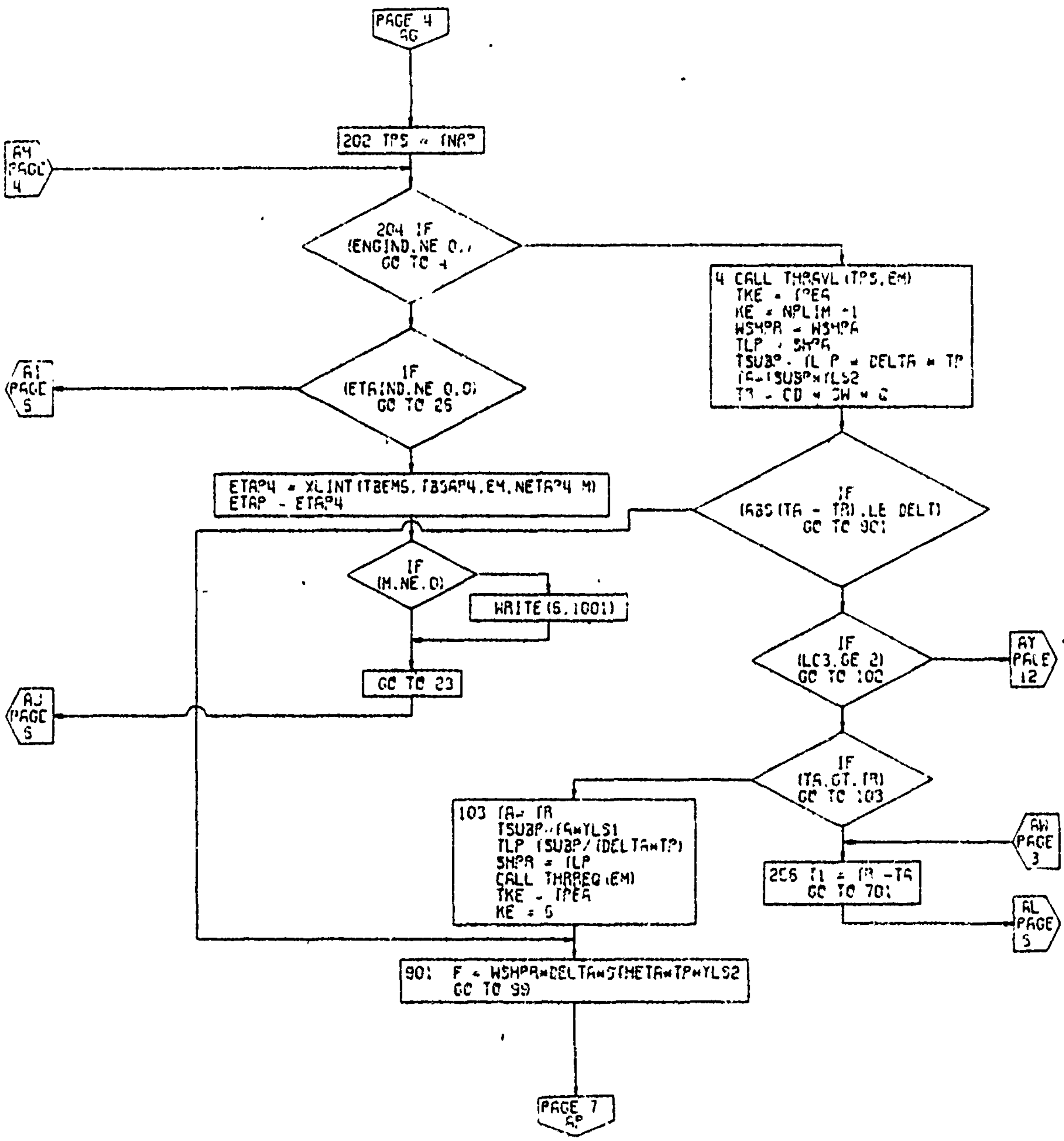


Figure 50B. CRUS1 Calculations Subroutine, Flow Chart (Part 4 of 10)

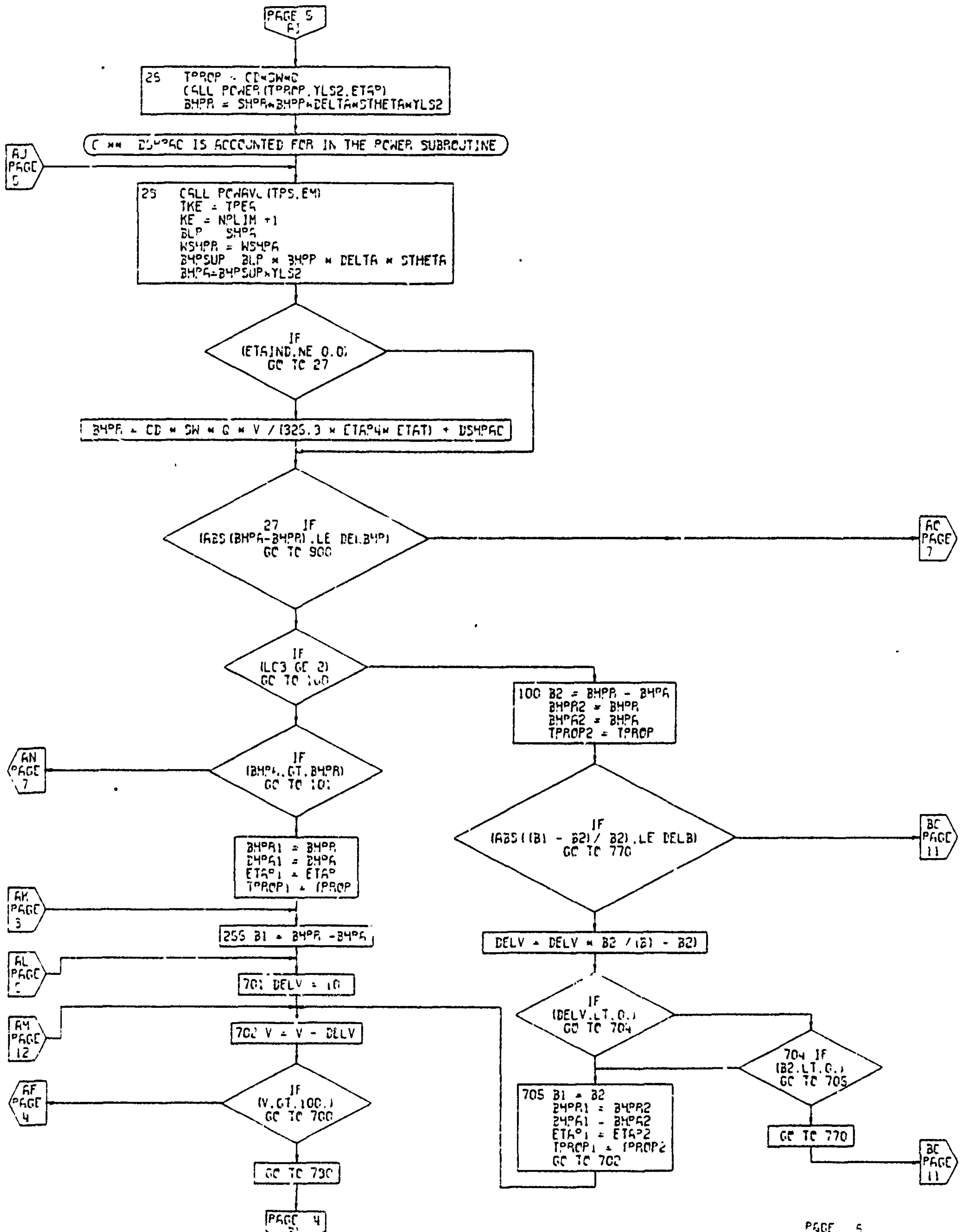


Figure 50B. CRUS1 Calculations Subroutine, Flow Chart (Part 5 of 10)

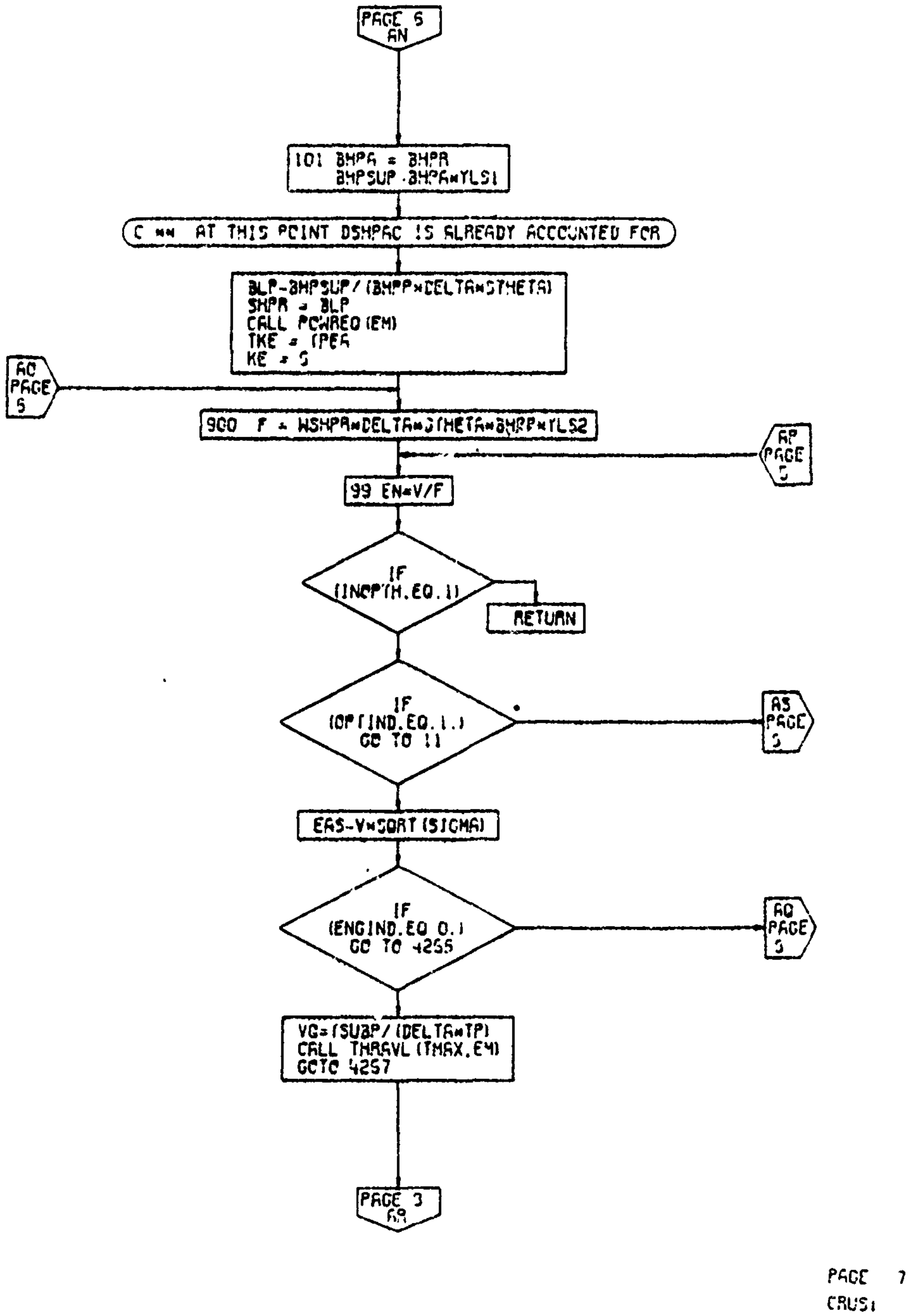


Figure 50B. CRUS1 Calculations Subroutine, Flow Chart (Part 6 of 10)

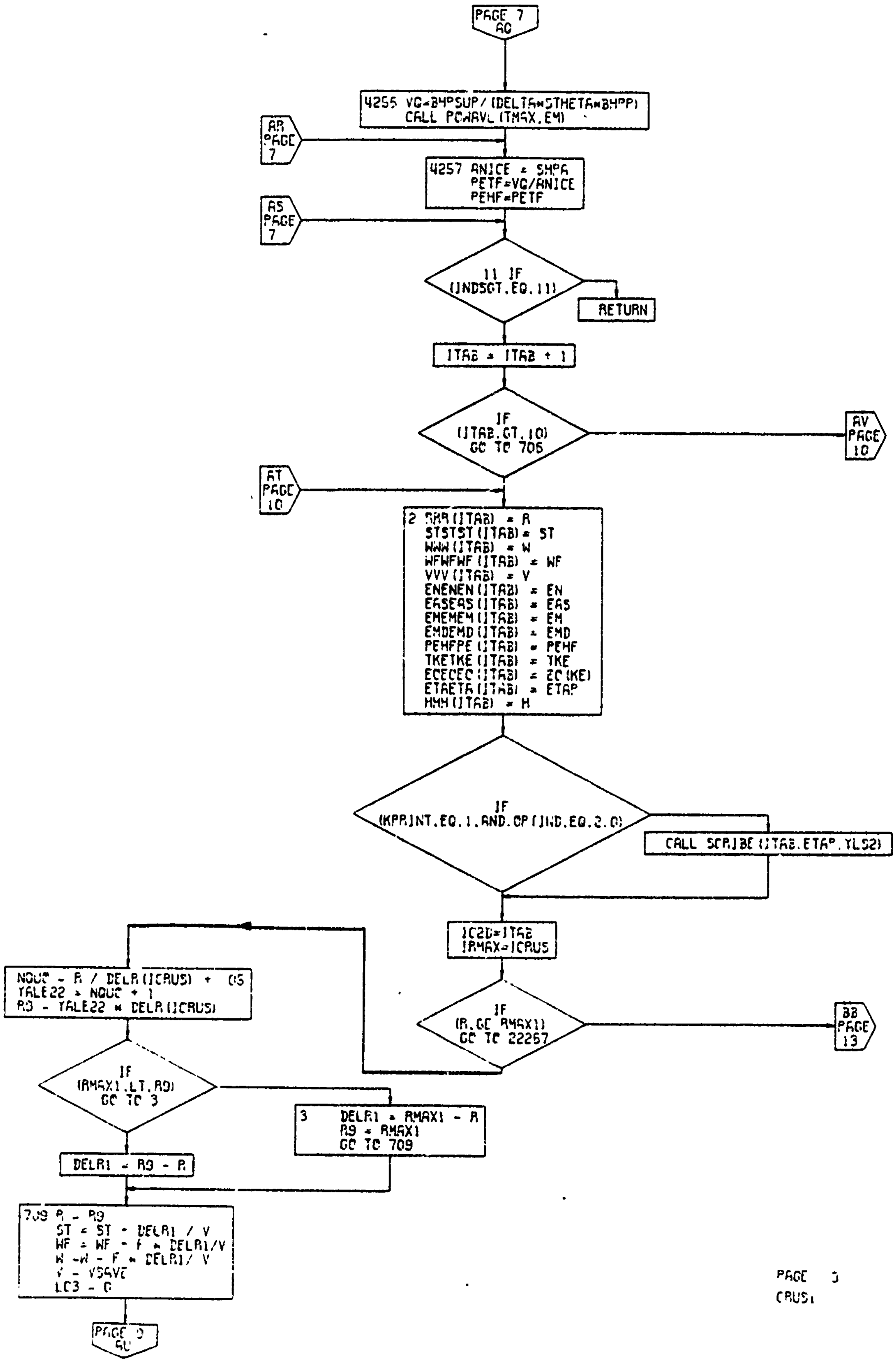


Figure 50B. CRUS1 Calculations Subroutine, Flow

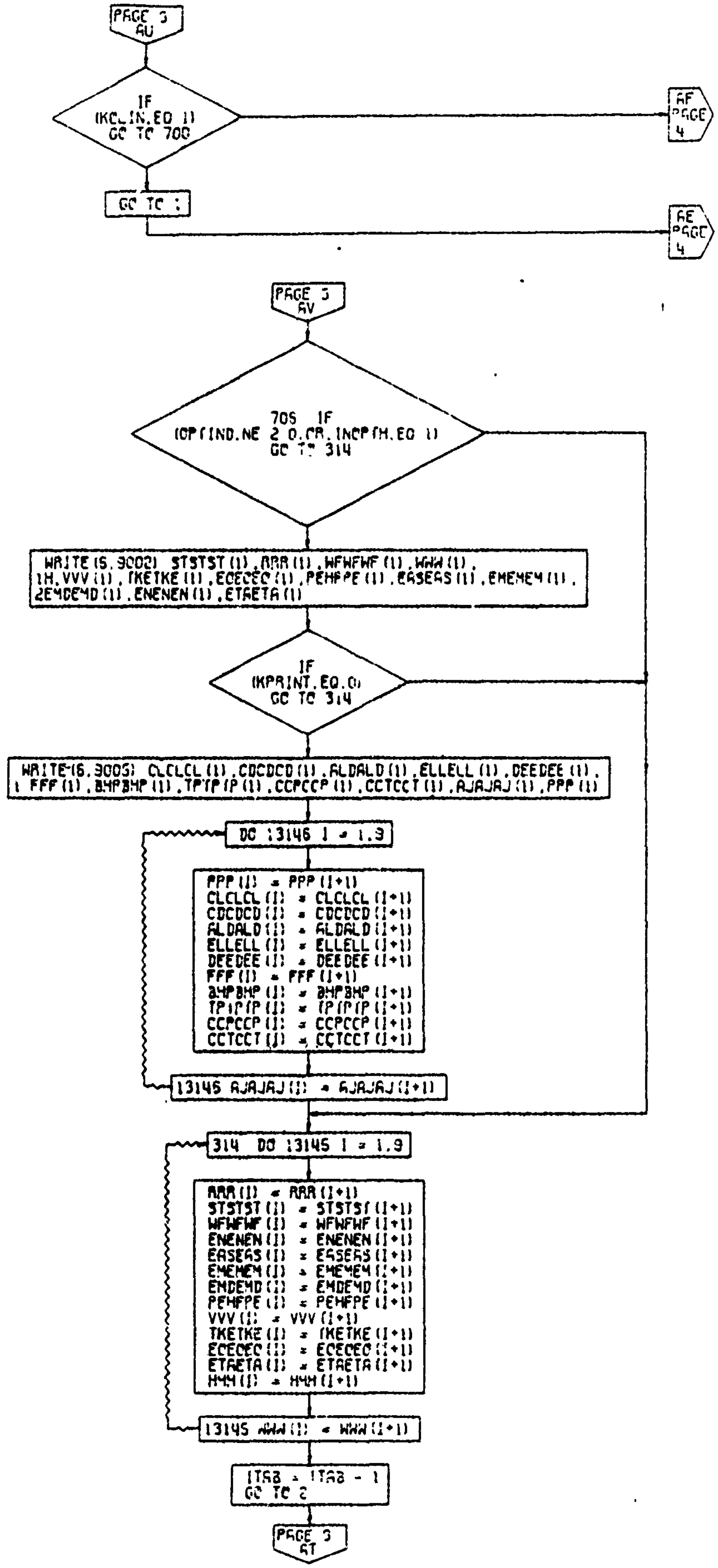


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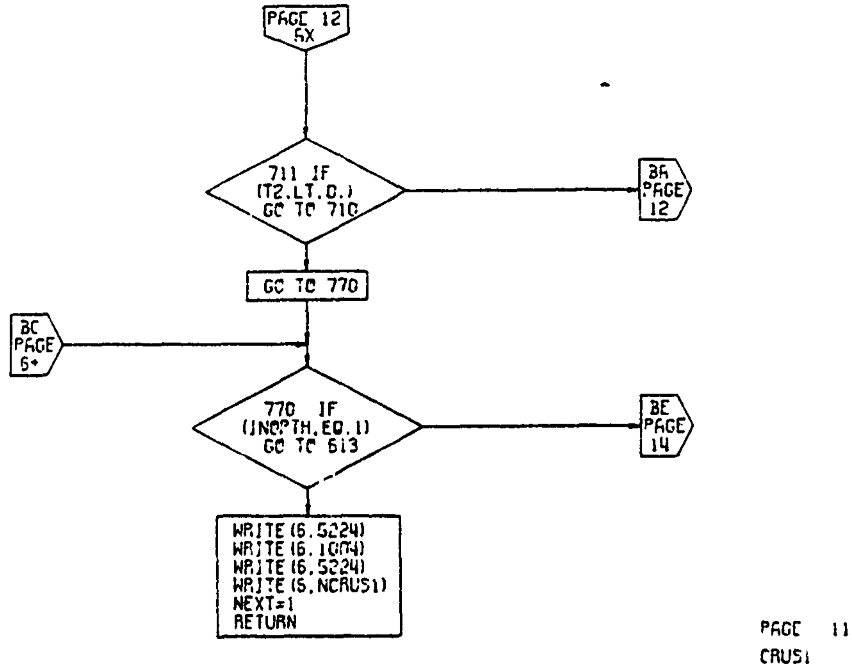
Figure 50B. CRUS1 Calculations Subroutine, Flow Chart (Part 8 of 10)



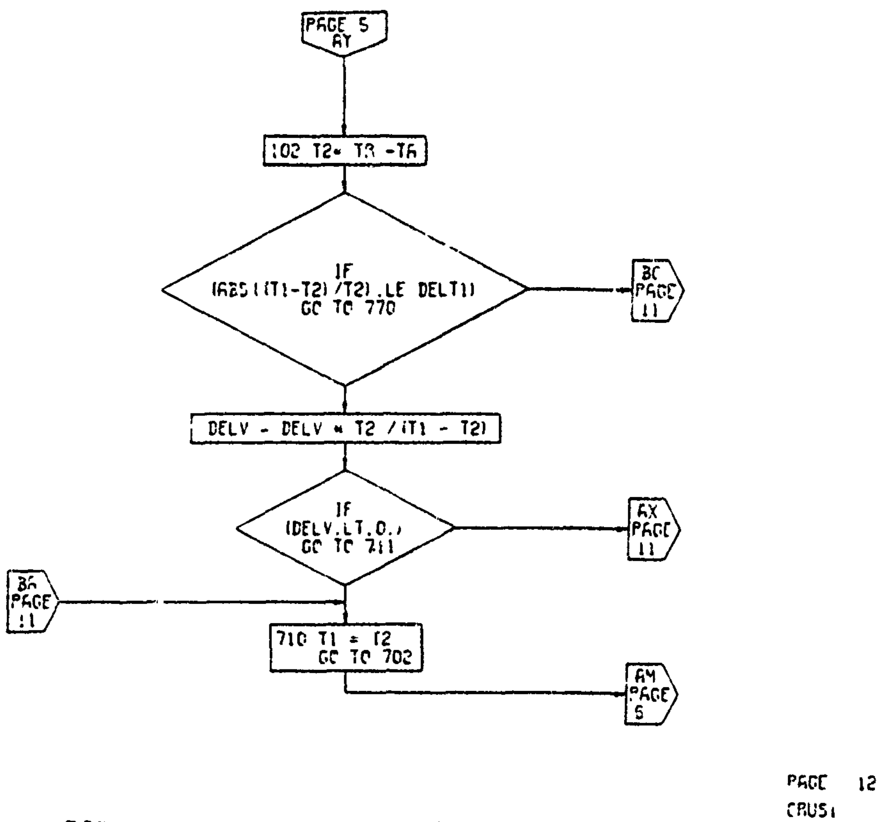
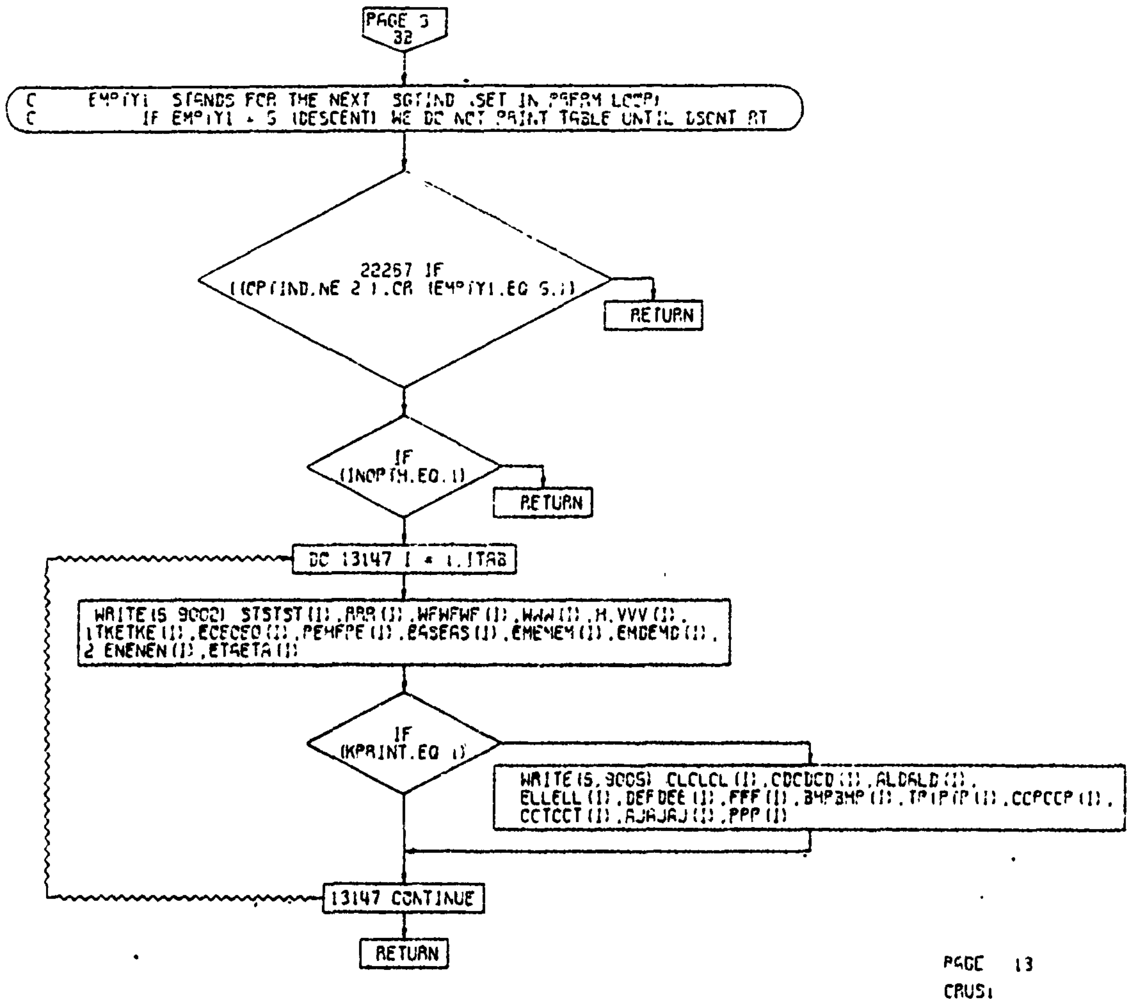


Figure 50B. CRUS1 Calculations Subroutine, Flow Chart (Part 9 of 10)



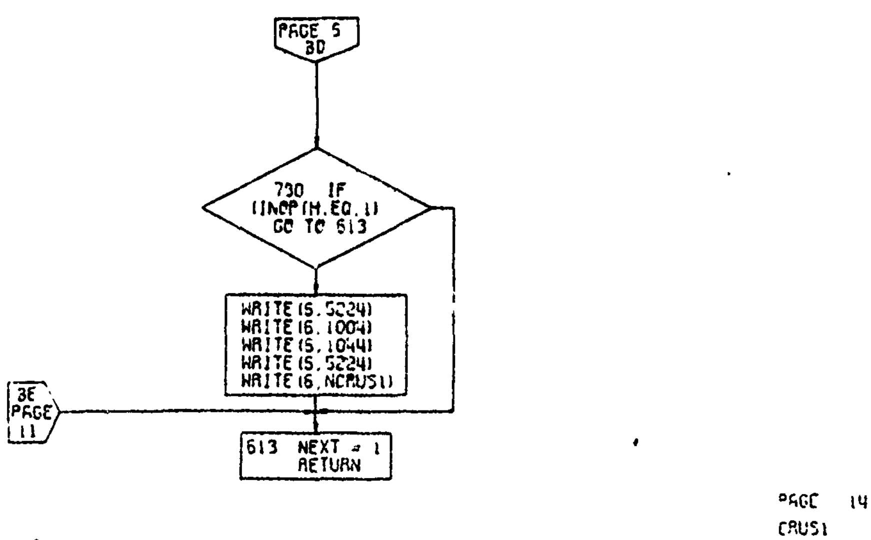


Figure 50B. CRUS1 Calculations Subroutine, Flow Chart (Part 10 of 10)

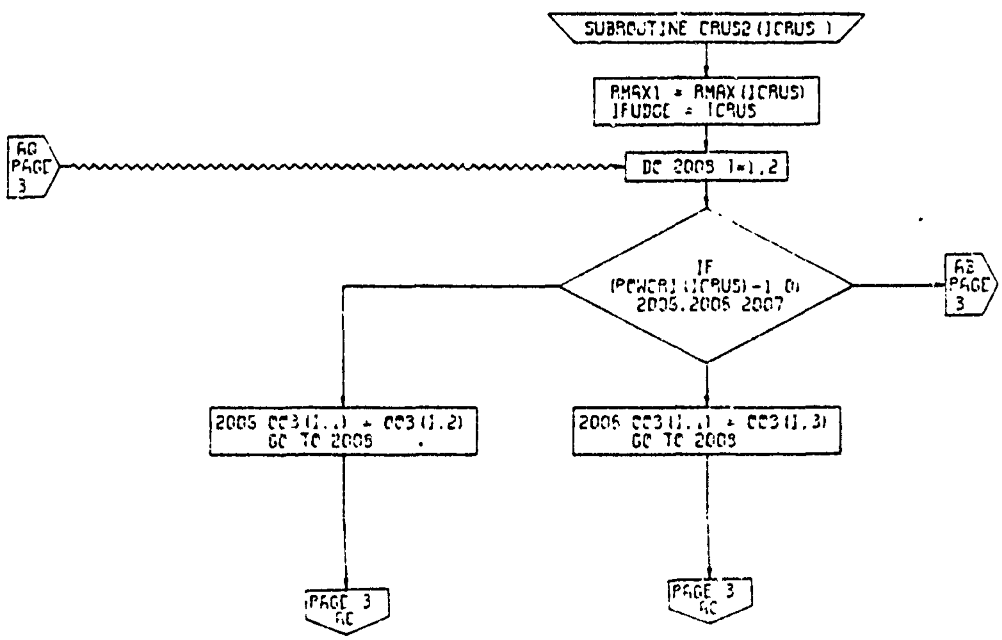


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Figure 50C . CRUS2 Calculations Subroutine, Flow Chart (Part 1 of 8)

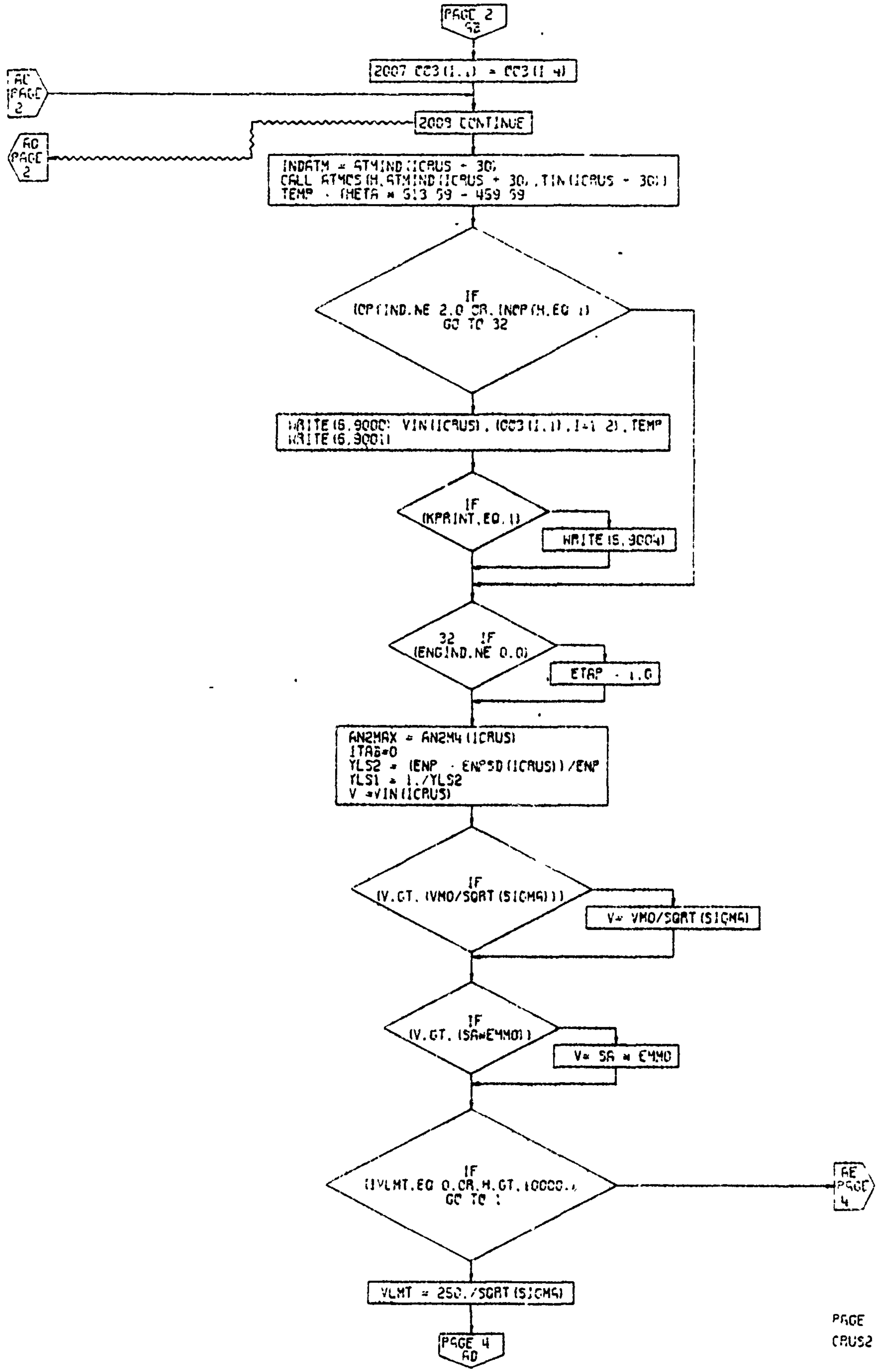

Figure 50C. CRUS2 Calculations Subroutine, Flow Chart (Part 2 of 8)

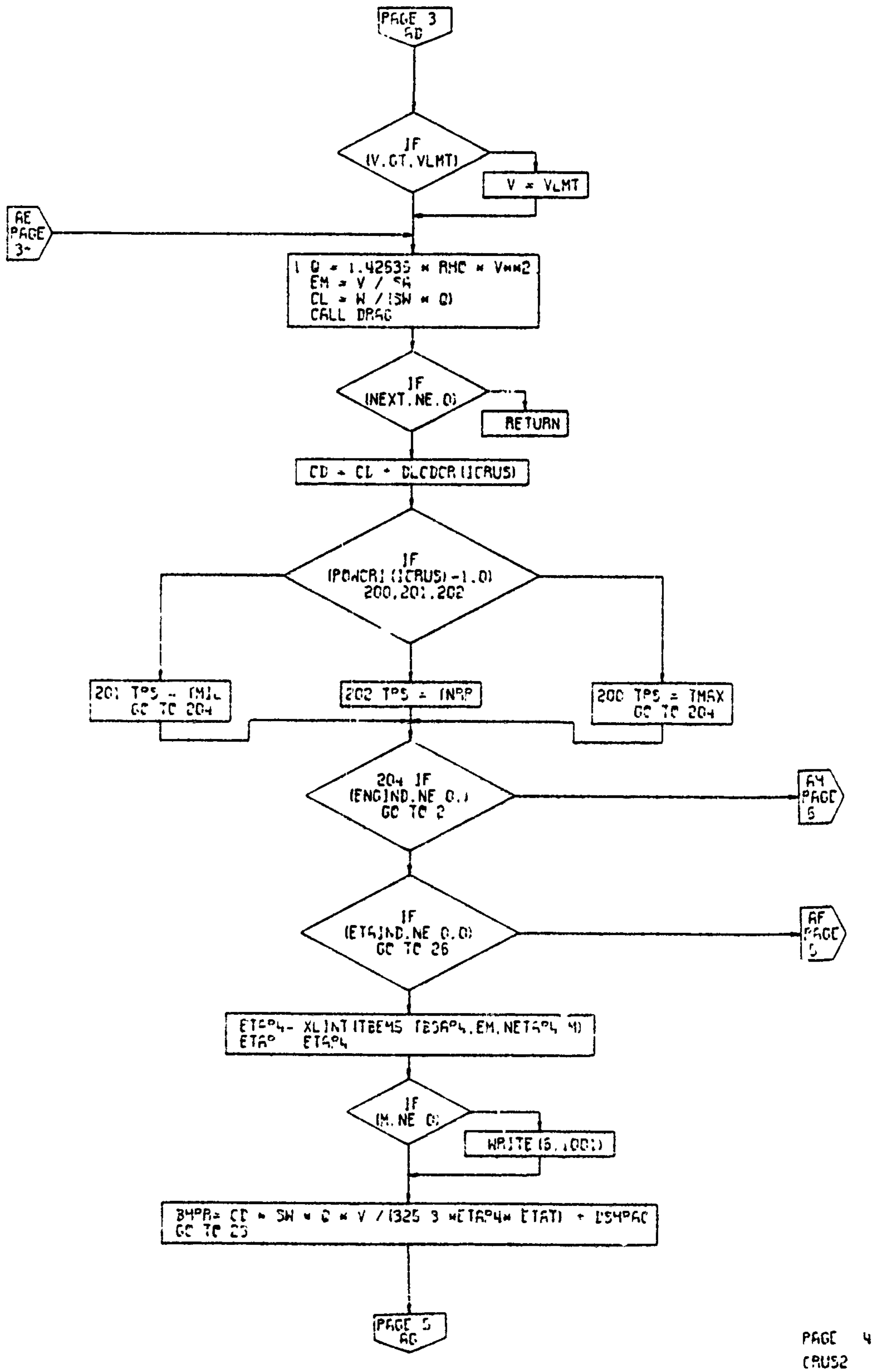

Figure 50C. CRUS2 Calculations Subroutine, Flow Chart (Part 3 of 8)

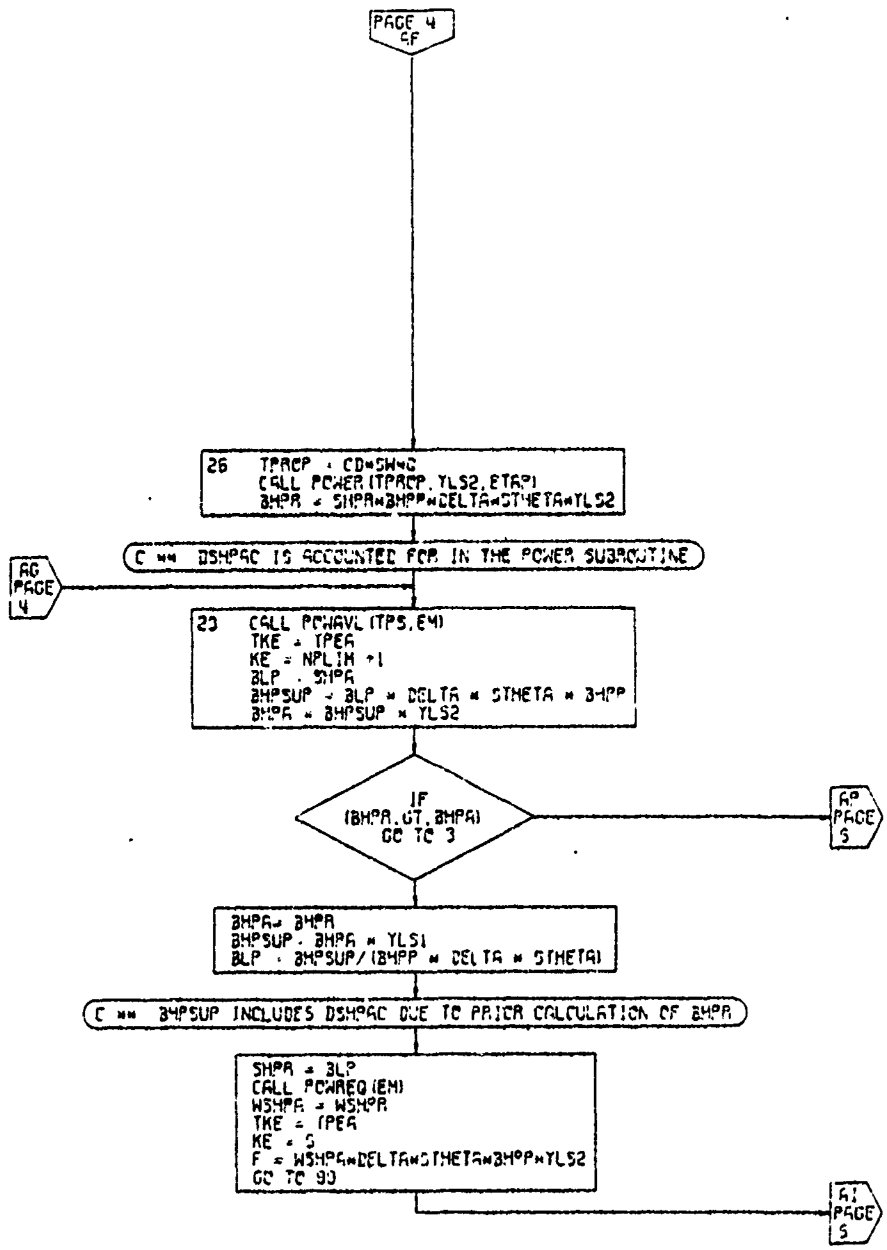

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Figure 50C. CRUS2 Calculations Subroutine, Flow Chart (Part 4 of 8)

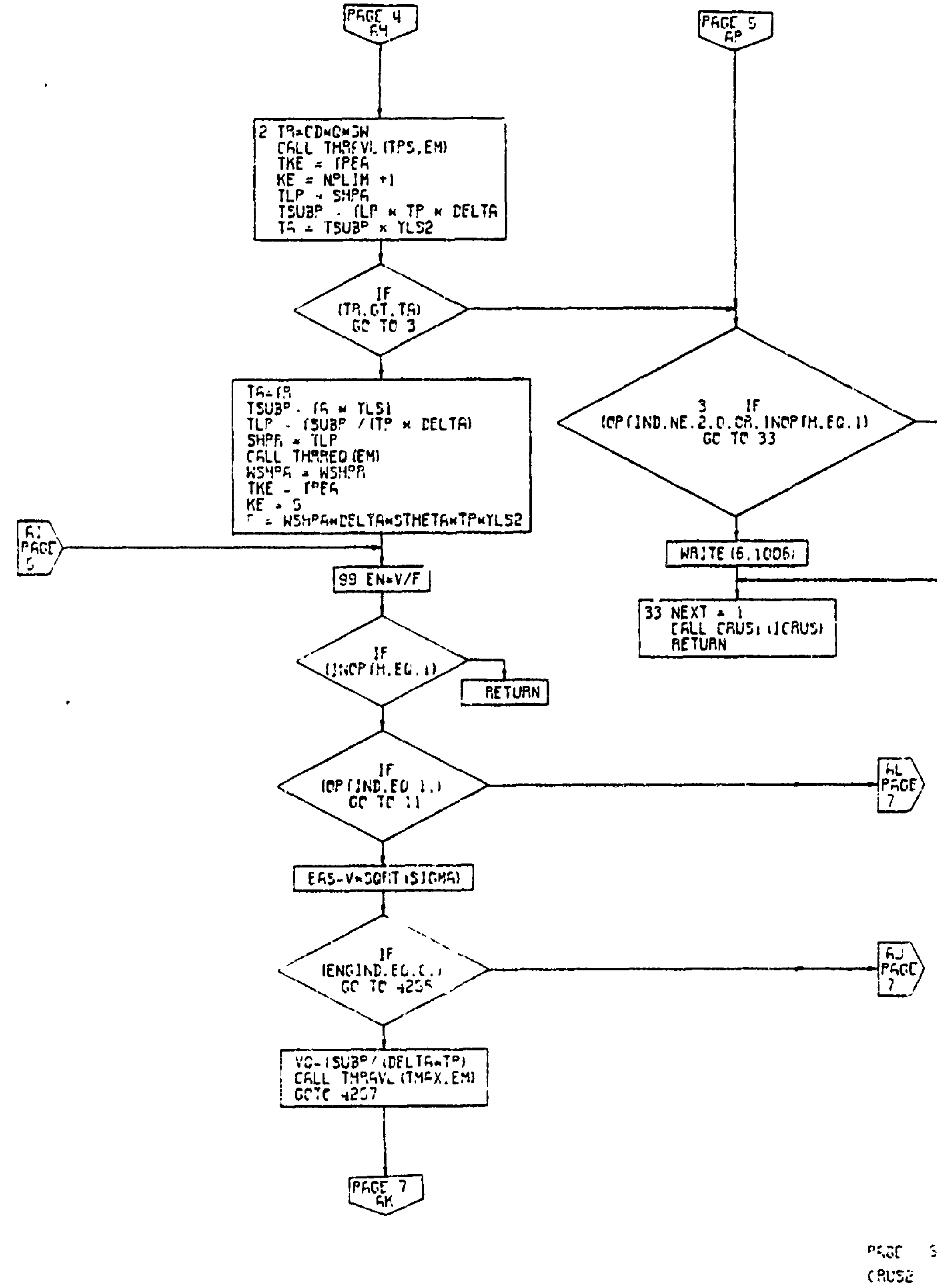

Figure 50C. CRUS2 Calculations Subroutine, Flow Chart (Part 5 of 8)

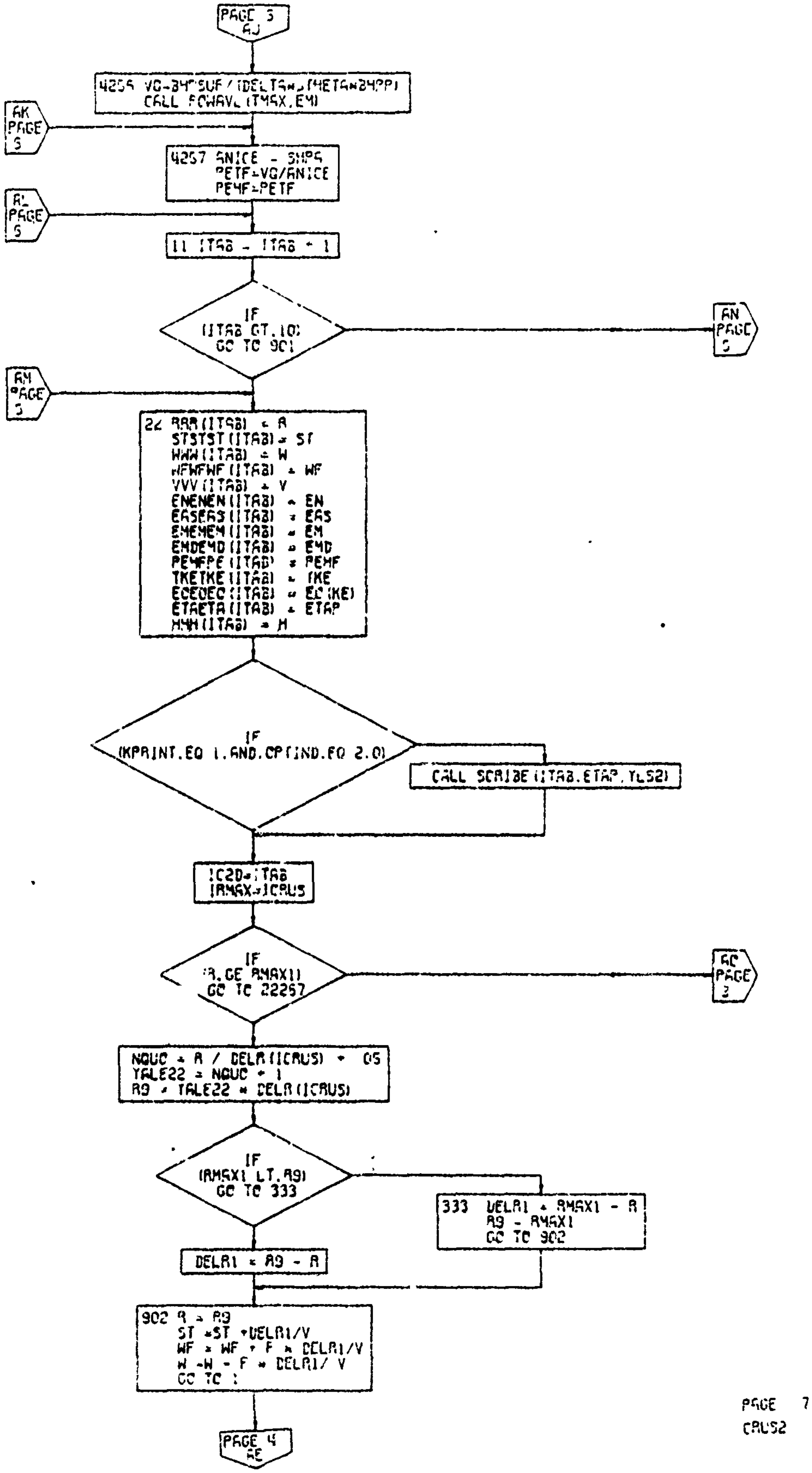

Figure 50C. CRUS2 Calculations Subroutine, Flow Chart (Part 6 of 8)

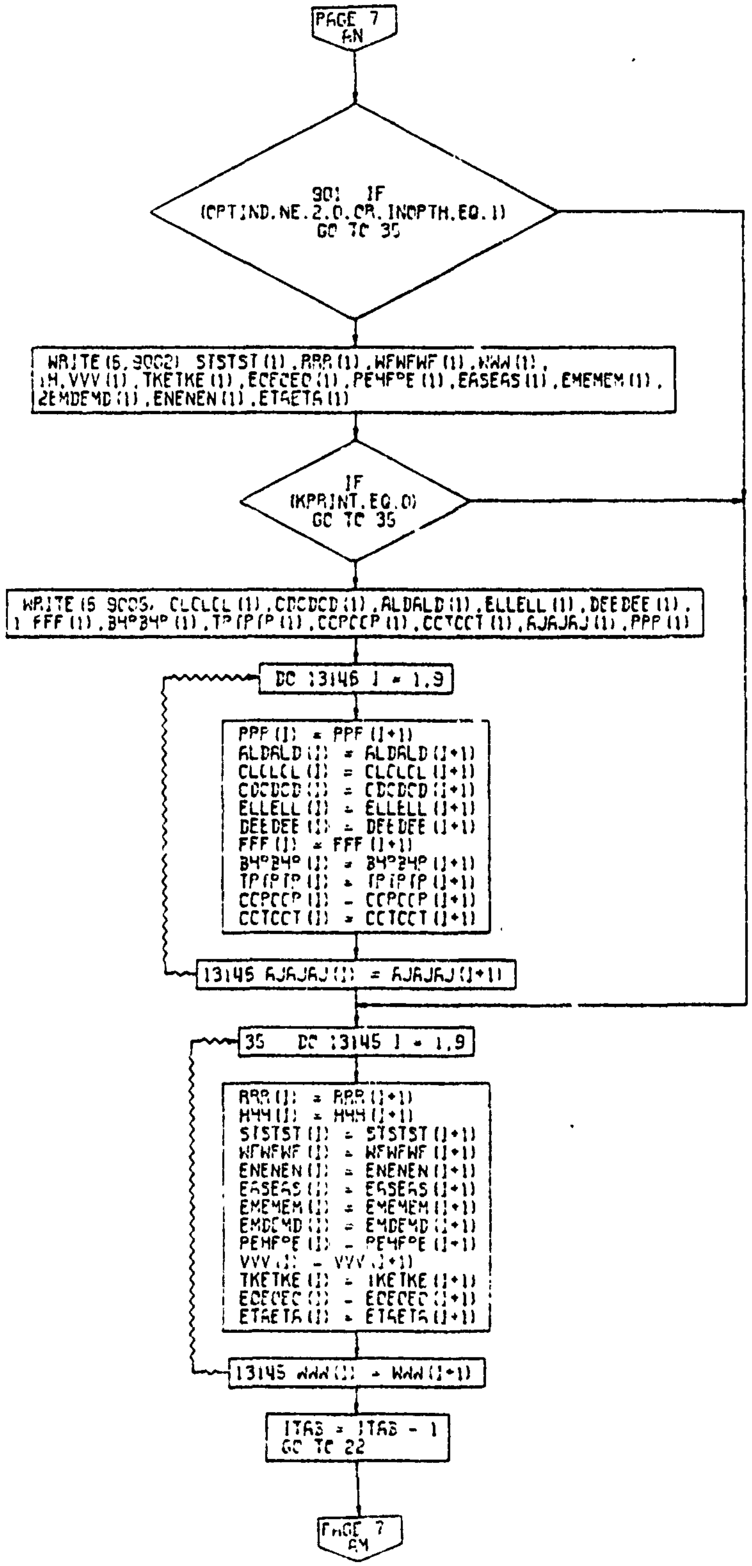

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Figure 50C. CRUS2 Calculations Subroutine, Flow Chart (Part 7 of 8)

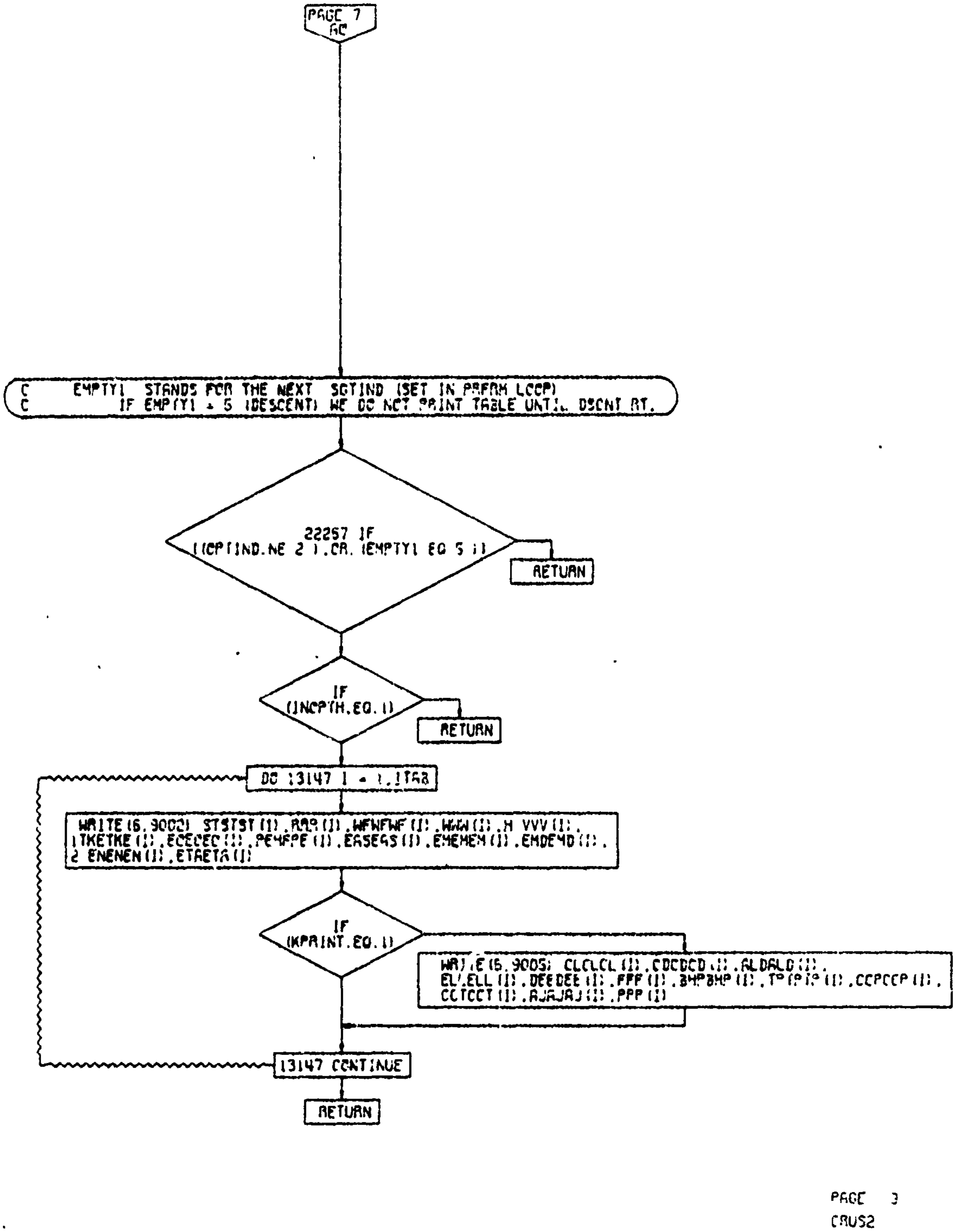

Figure 50C. CRUS2 Calculations Subroutine, Flow Chart (Part 8 of 8)

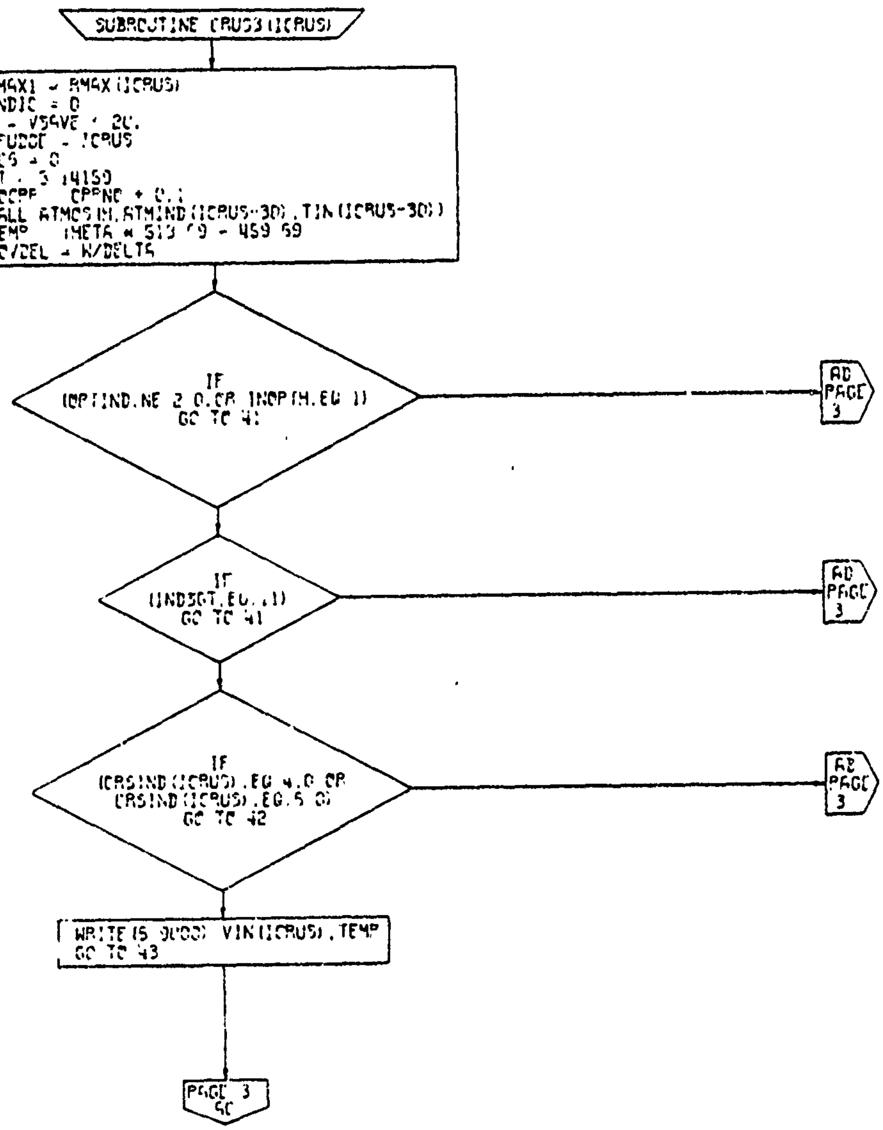

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Figure 50D. CRUS3 Calculations Subroutine, Flow Chart (Part 1 of 13)

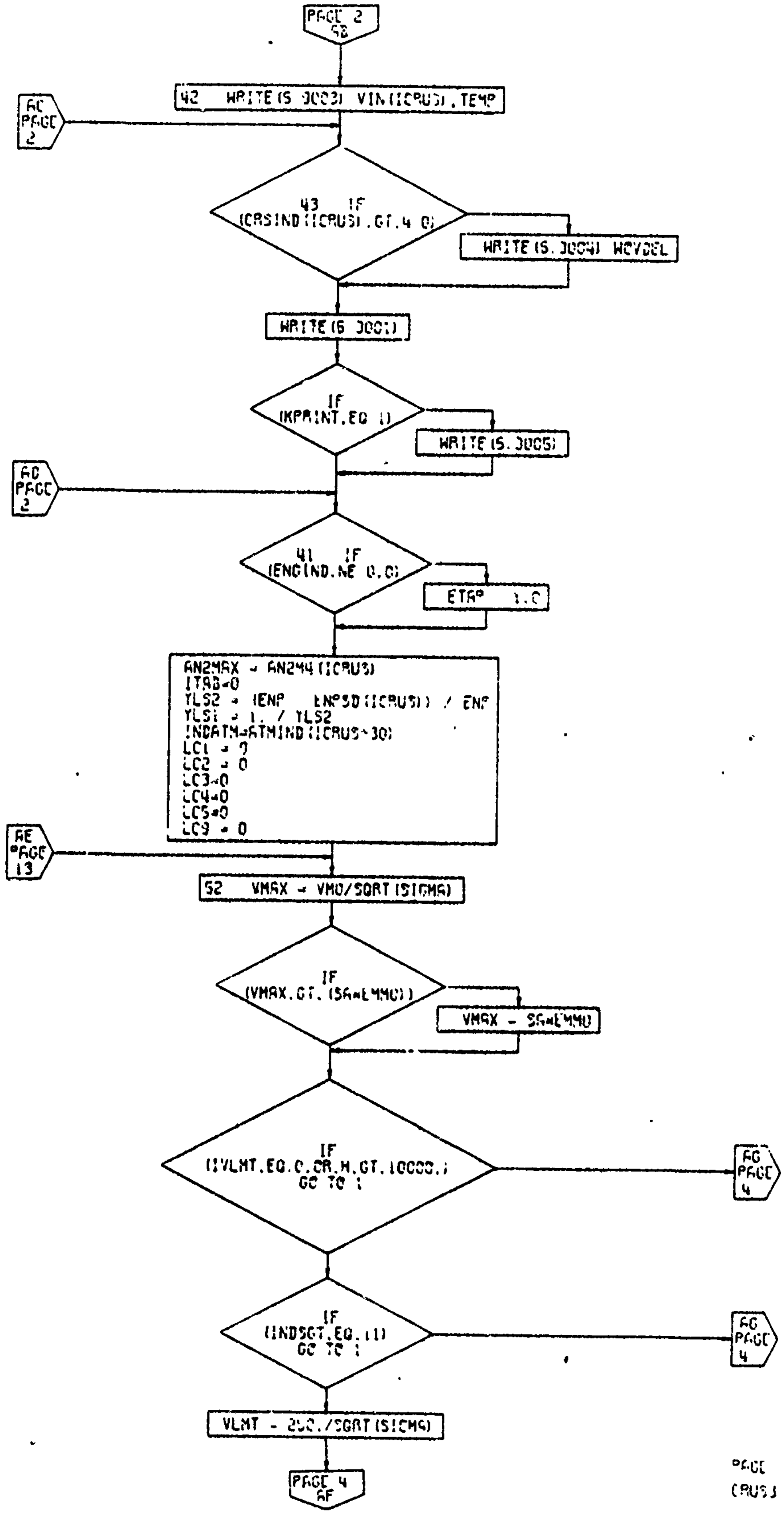


Figure 50D, CRUS3 Calculations Subroutine, Flow Chart (Part 2 of 13)

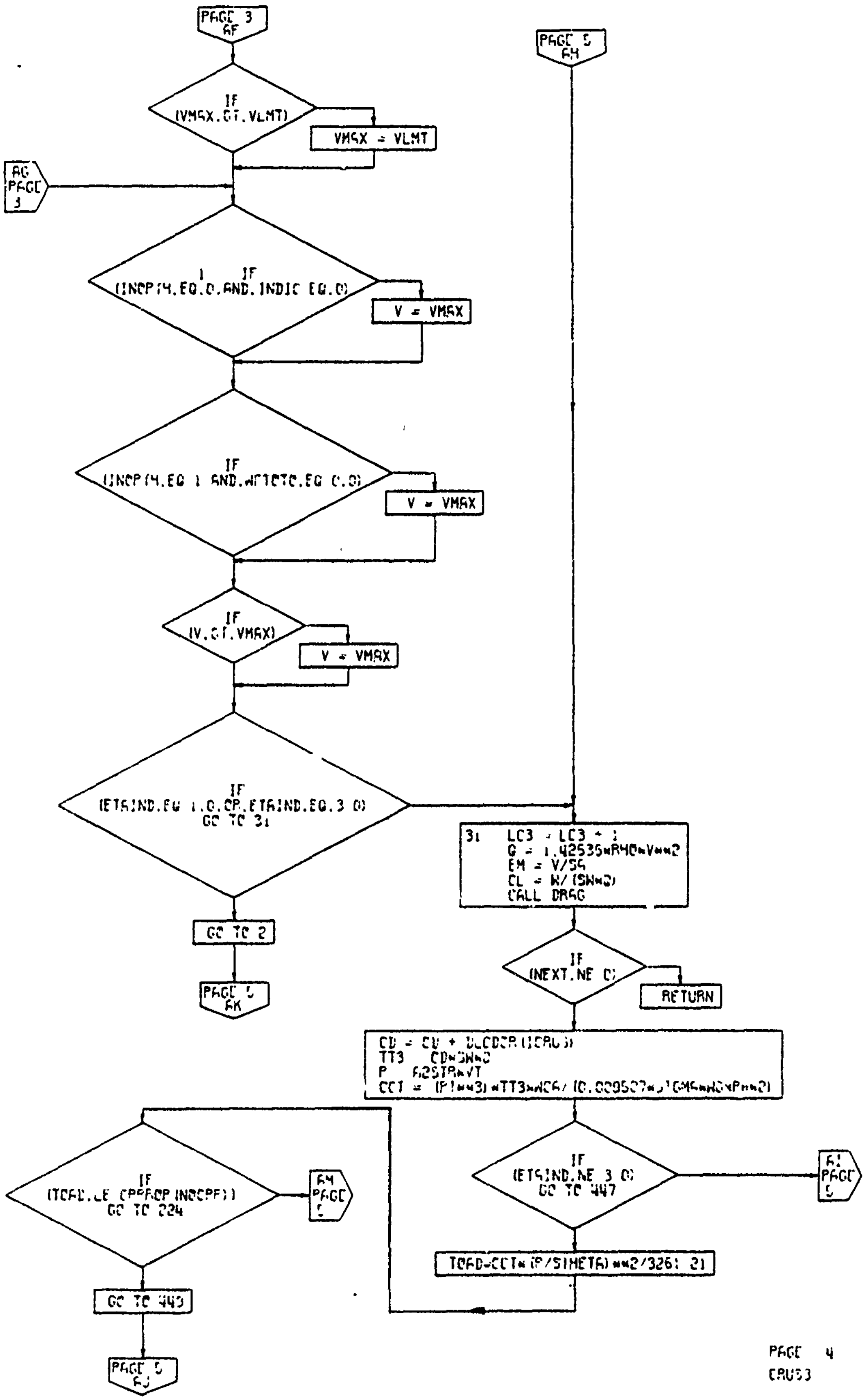


Figure 50D. CRUS3 Calculations Subroutine, Flow Chart (Part 3 of 13)

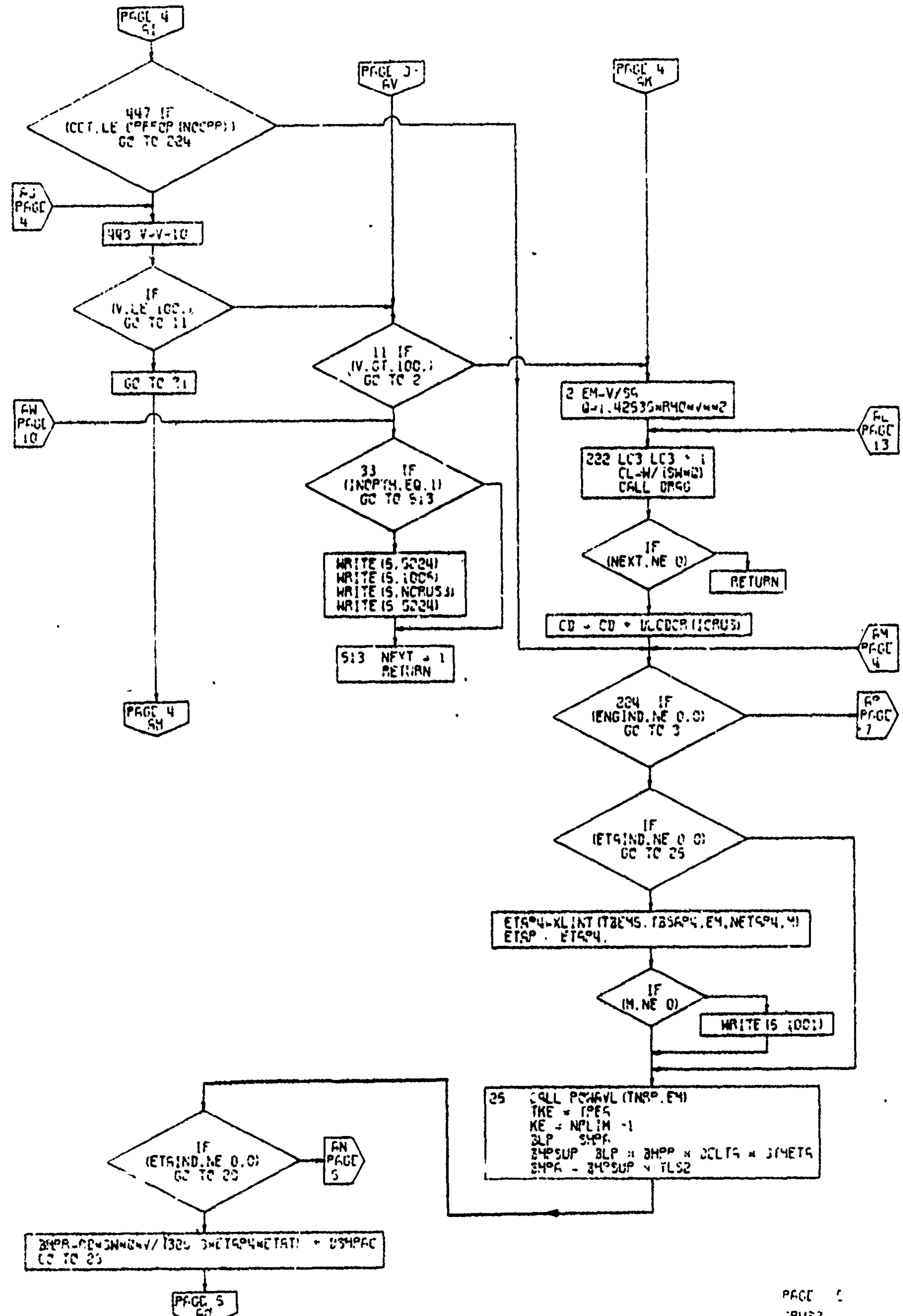


Figure 50D. CRUS3 Calculations Subroutine, Flow Chart (Part 5 of 13)

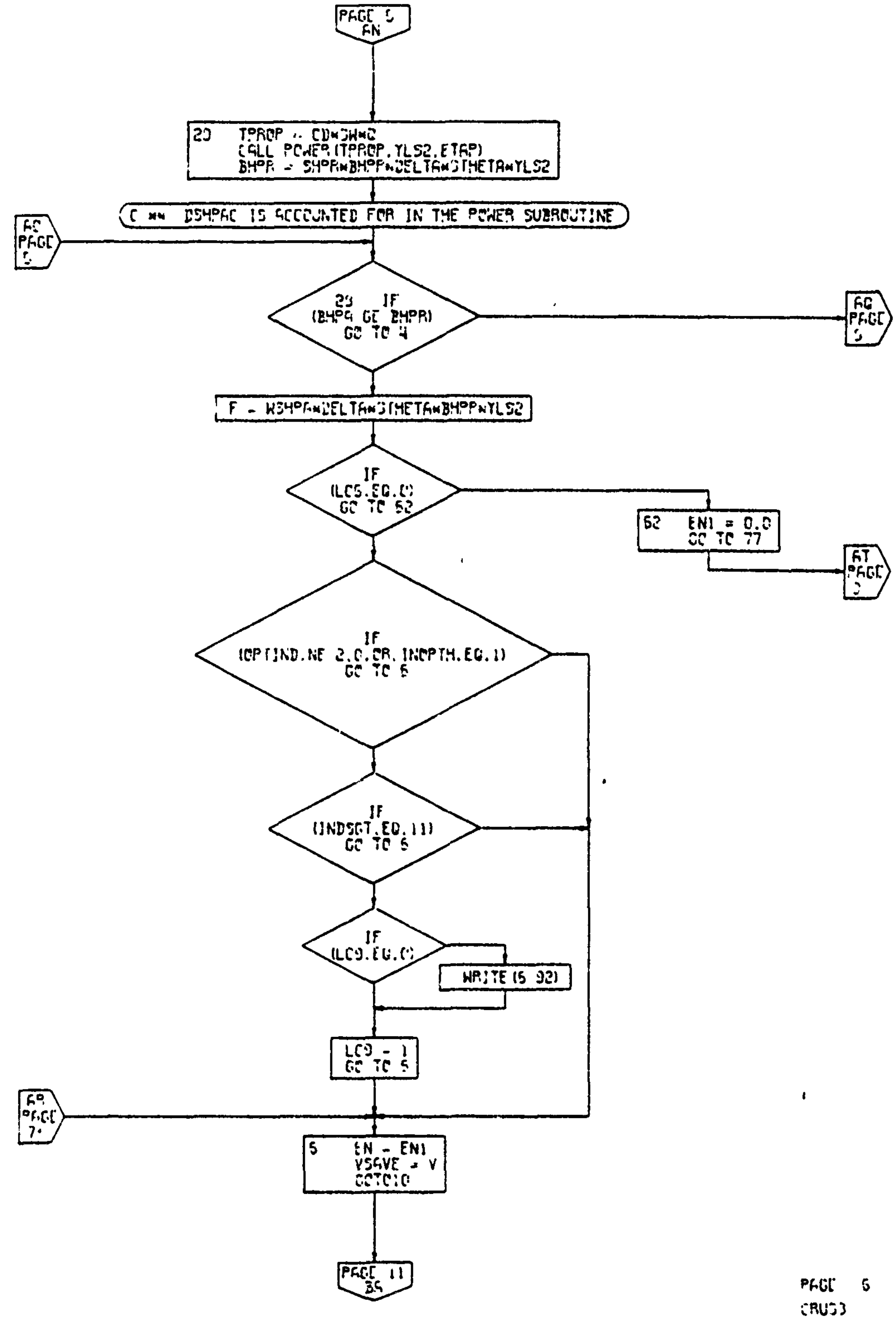


Figure 50D. CRUS3 Calculations Subroutine, Flow Chart (Part 4 of 13)

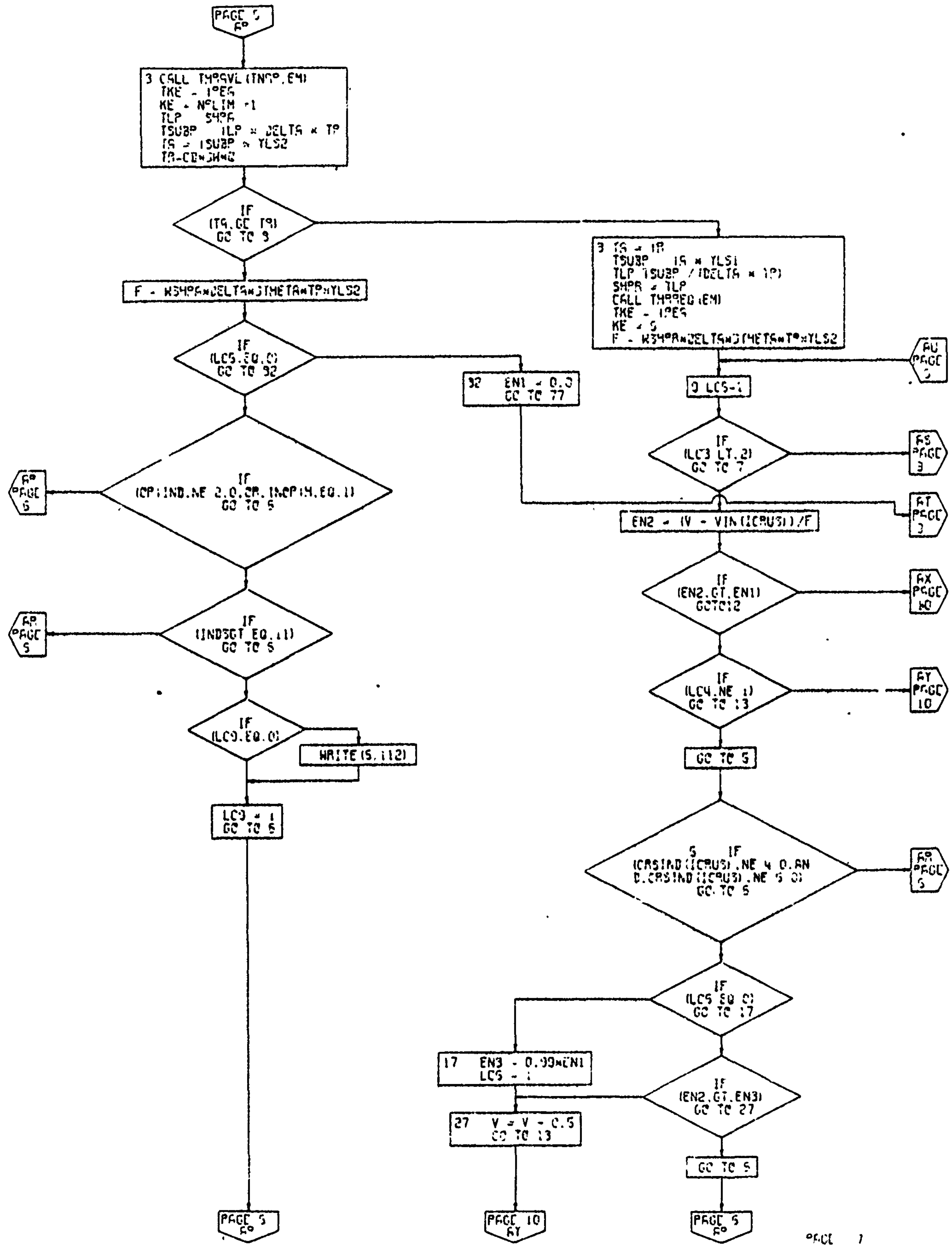
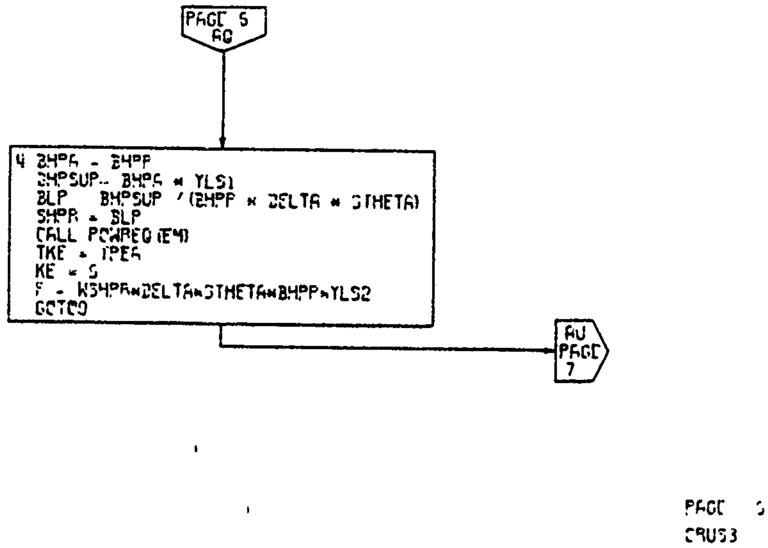


Figure 50D. CRUS3 Calculations Subroutine, Flow Chart (Part 6 of 13)



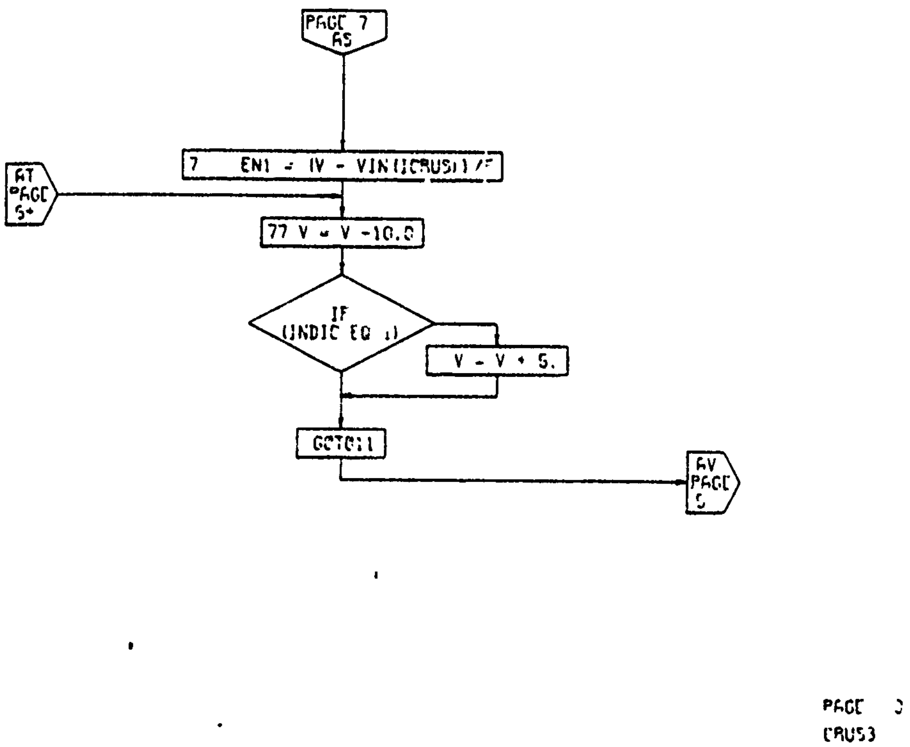


Figure 50D. CRUS3 Calculations Subroutine, Flow Chart (Part 7 of 13)

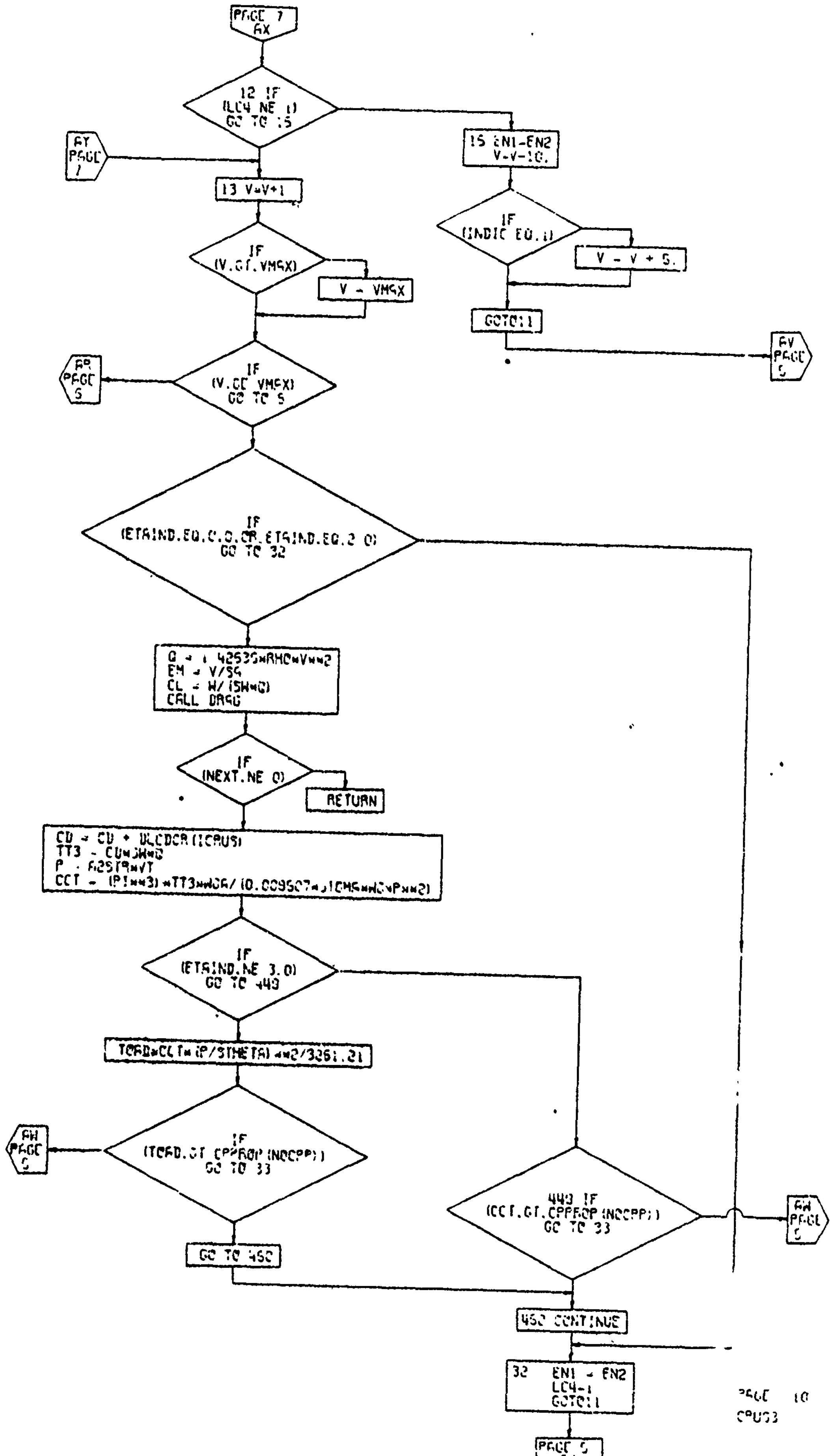


Figure 50D. CRUS3 Calculations Subroutine, Flow Chart (Part 8 of 13)

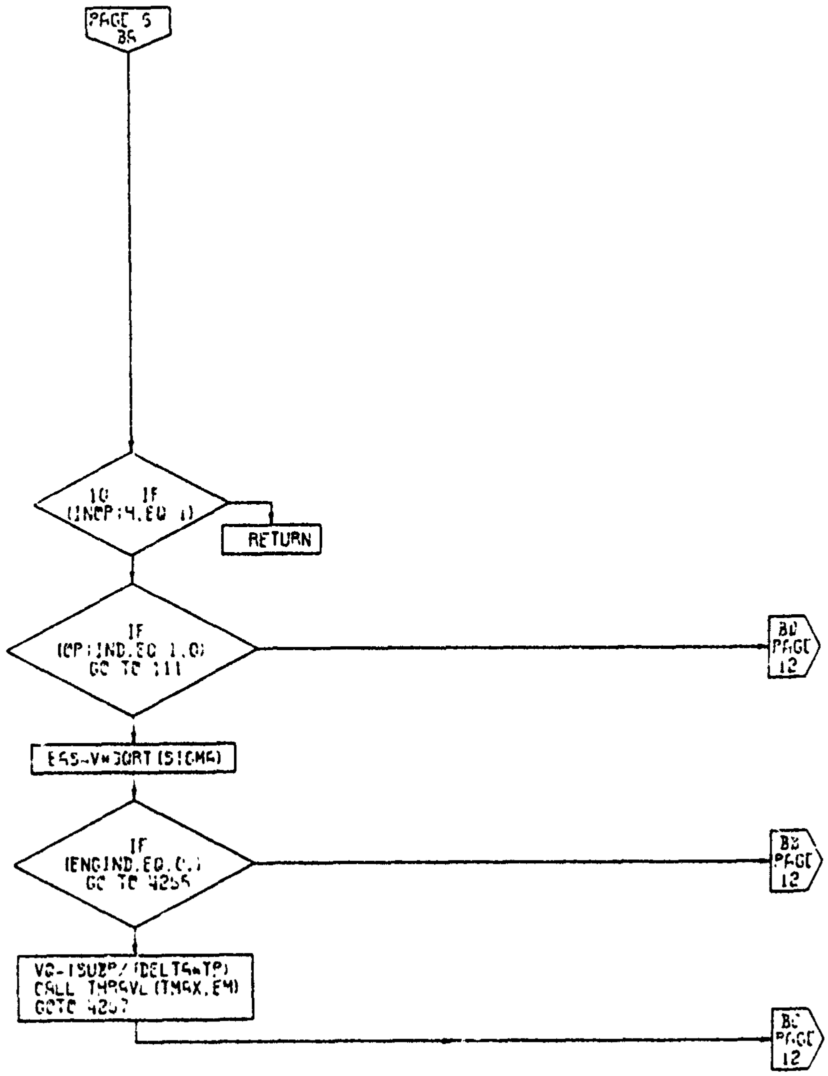


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Figure 50D. CRUS3 Calculations Subroutine, Flow Chart (Part 9 of 13)

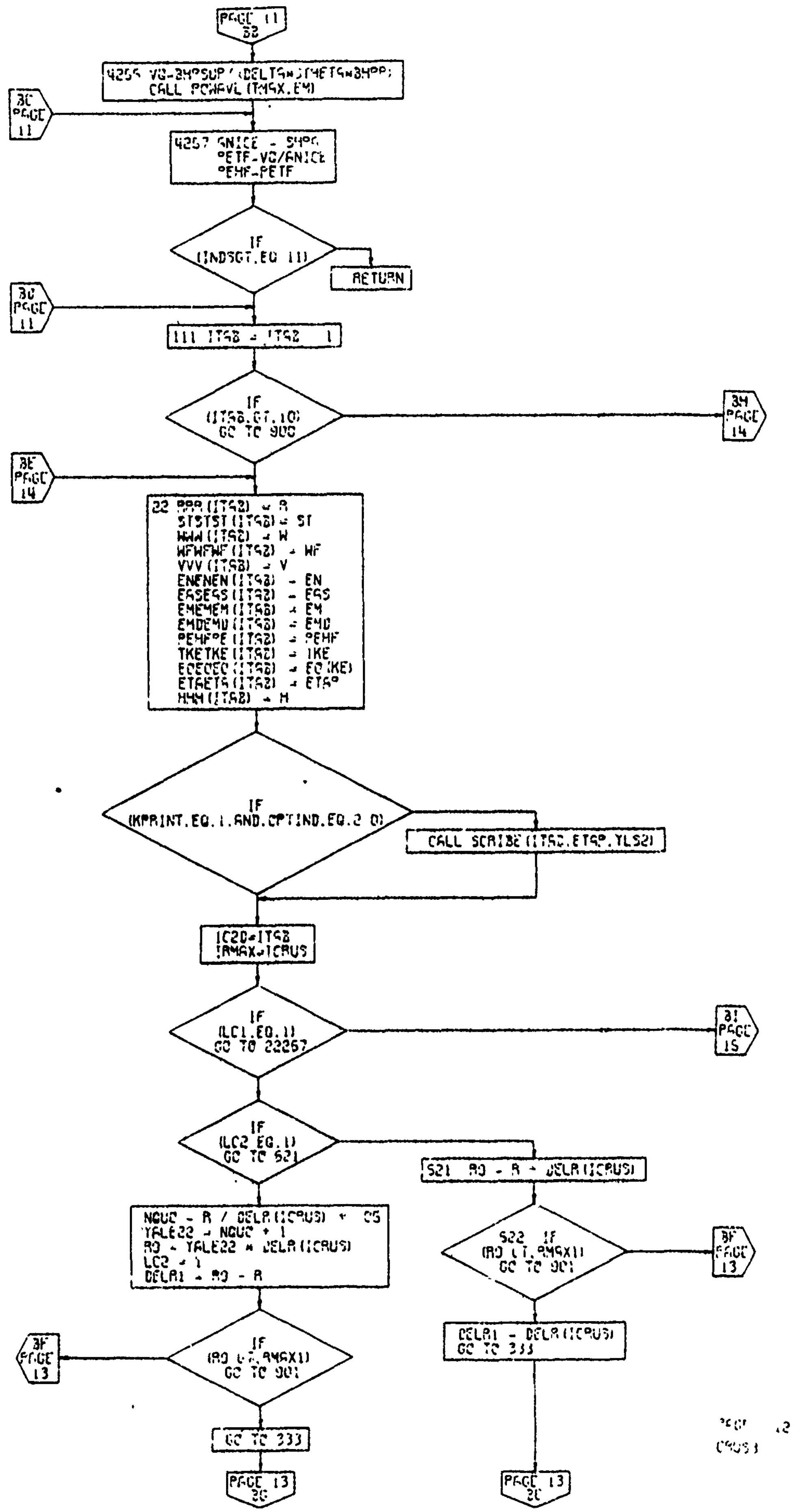


Figure 50D. CRUS3 Calculations Subroutine, Flow Chart (Part 10 of 13)

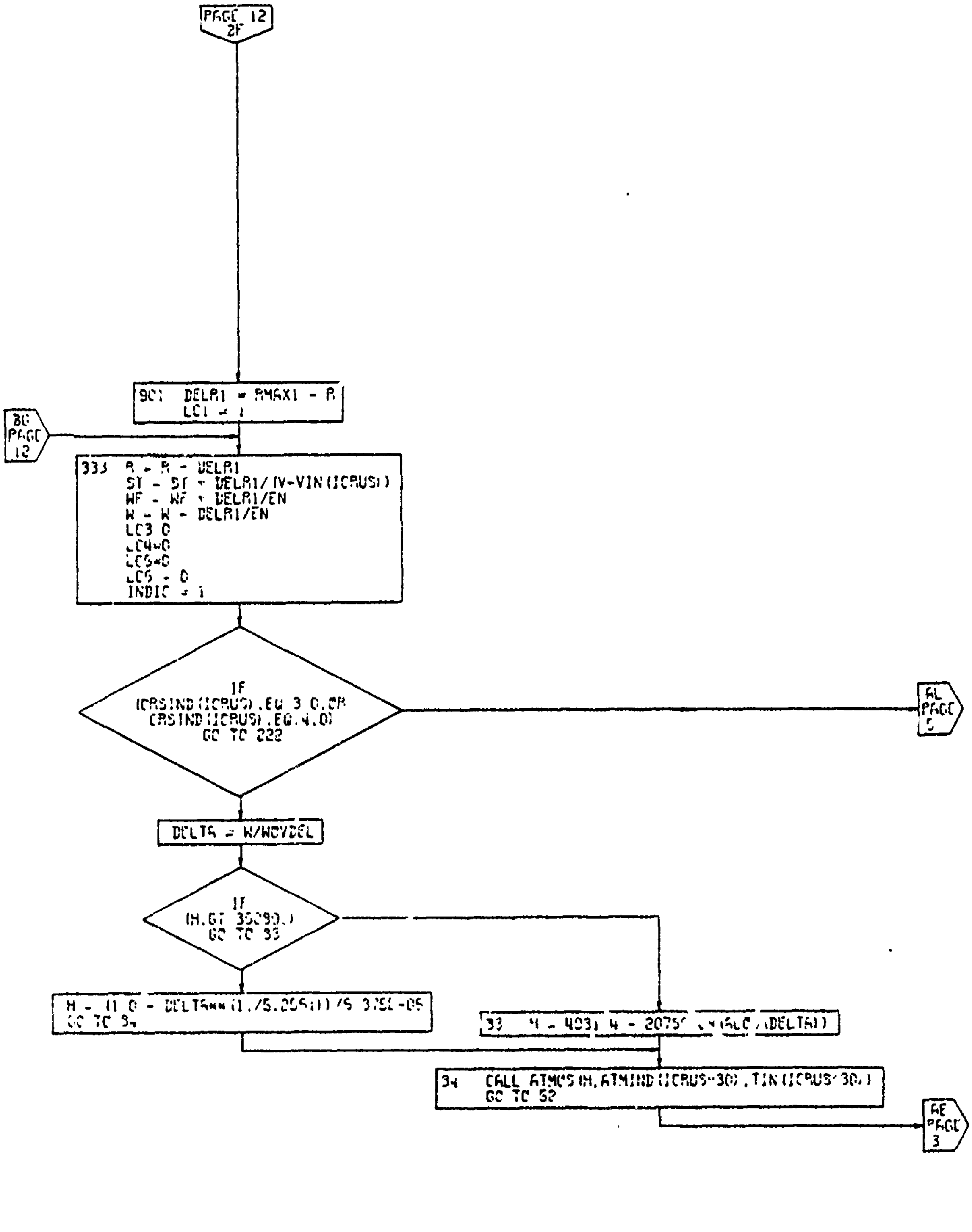


Figure 50D. CRUS3 Calculations Subroutine, Flow Chart (Part 11 of 13)

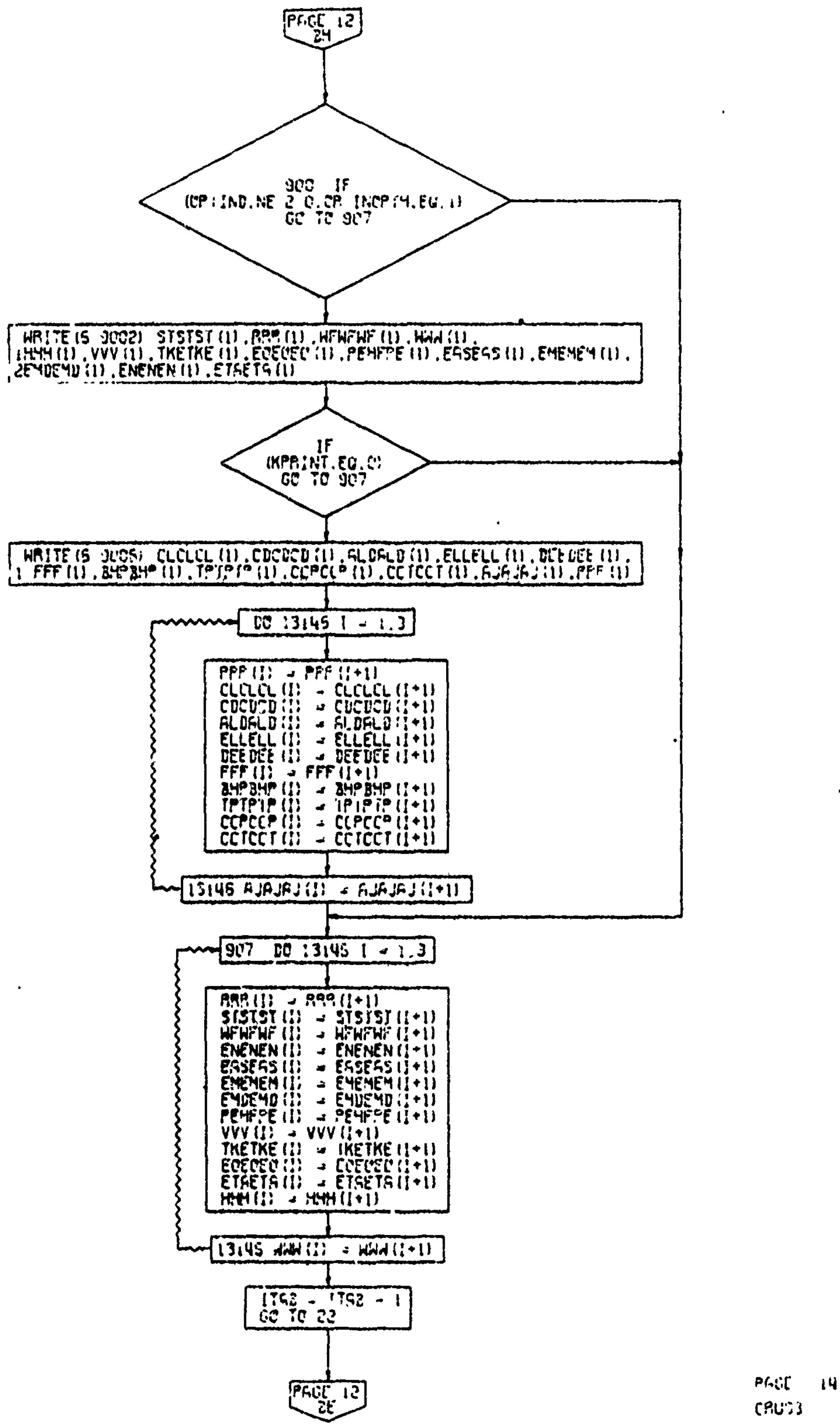


Figure 50D. CRUS3 Calculations Subroutine, Flow Chart (Part 12 of 13)

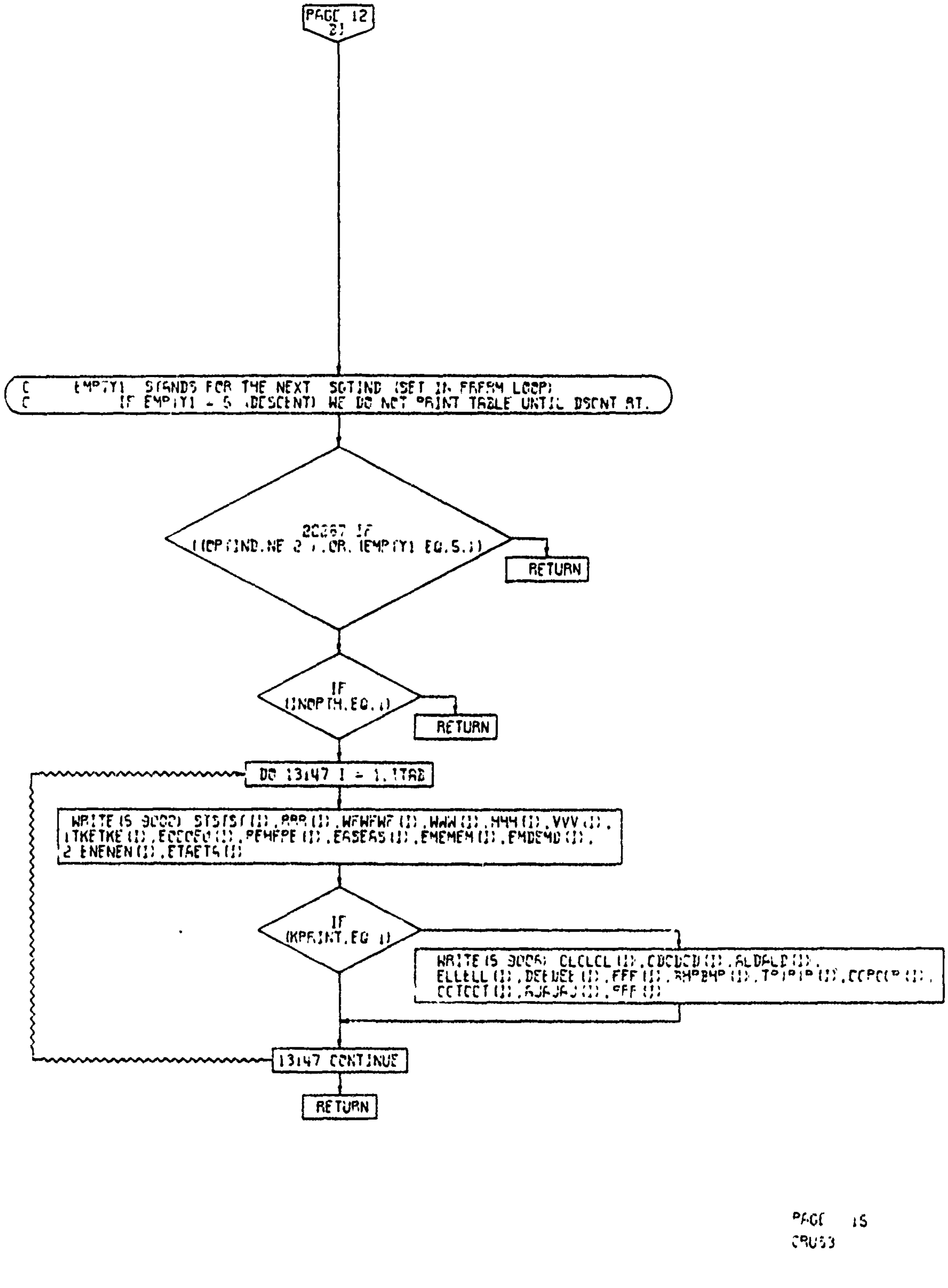


Figure 50D. CRUS3 Calculations Subroutine, Flow Chart (Part 13 of 13)

4.10.5 Descent Calculations Subroutine

Eight different options for descent performance calculation are available. The options fall into four different categories: maximum speed, idle power, constant EAS, and constant Mach number. In addition, each type of descent may be calculated with or without specification of range at the end of descent. The options, set by the input indicator DESIND, are:

Value of DESIND	Type of Descent	Terminal Range Specified?
1	Maximum Speed	Yes
2	Maximum Speed	No
3	Idle Power	Yes
4	Idle Power	No
5	Constant EAS	Yes
6	Constant EAS	No
7	Constant Mach Number	Yes
8	Constant Mach Number	No

All descents are limited by an input value of maximum negative body attitude angle. For the four categories of descent, the following methods are used to modulate power and/or airspeed:

Maximum speed The aircraft will always descend at maximum permissible airspeed (V_{MO} or M_{MO}). This condition corresponds to maximum rate of sink. The power setting will be flight idle unless the body attitude angle falls below the prescribed minimum, in which case the power will be increased (up to normal power level) to the value required to satisfy the cabin angle restriction.

Idle power The aircraft will always use flight idle power setting. The descent will occur at maximum speed unless the cabin angle limit is violated, in which case the airspeed for descent will be decreased.

Constant EAS and Constant Mach number The aircraft will always fly at the specified equivalent airspeed or Mach number. If terminal range is not specified, the engine setting will be flight idle unless this causes the body angle to become too steep, in which case the power will be set to the required level. If terminal range is specified, the aircraft will fly a straight-line descent path to the required terminal point and will modulate power accordingly. If either body angle becomes too steep or power

required is greater than normal power, the aircraft will fly at the power setting required to satisfy the corresponding limit. The terminal range will not be satisfied and the program, upon reaching the final altitude, will set the range to the required value with the note: "SPIRAL DESCENT PATH REQUIRED". If body angle becomes too steep and the required power setting is greater than normal power, the program will terminate with the note: "DESCENT CONDITION IMPOSSIBLE: DESIRED FLIGHT PATH IS TOO SHALLOW".

Figure 4-51, in which the rate of sink is plotted against airspeed, illustrates the difference between the maximum speed and the flight idle options. The aircraft is able to make a steady-state descent anywhere within the boundaries shown on this figure. The critical boundaries are:

a. The idle power boundary, defined by the minimum power (flight idle setting) of the aircraft.

b. The fuselage attitude angle boundary, defined by the most negative permissible body attitude angle (θ_F).

c. The maximum speed boundary, defined by the maximum operating airspeed (V_{MO}) or the maximum operating Mach number (M_{MO}).

In the general case (Figure 4-51a), a descent at maximum rate of sink (DESIND = 1,2) will occur at point "A" at a power setting somewhat above flight idle. This option will give the fastest descent. A descent at flight idle power setting (DESIND = 3,4) will occur at point "B" at an airspeed somewhat below V_{MO}, M_{MO}. This option will give the descent at minimum power and thus at minimum fuel flow rate. This descent will approximate (although not be exactly equal to) a minimum fuel consumption descent. Possible variations on the general case are shown in Figures 4-51b through 4-51d. In Figure 4-51b, the attitude angle restriction is relatively large and the options are the same. That is, the aircraft is capable of descending at an airspeed corresponding to V_{MO}, M_{MO} and at a flight idle power setting without exceeding the fuselage angle limit. In Figures 4-51c and 4-51d, the airspeed limit has been set higher than the aircraft cruise speed (that is, even at normal power the aircraft will descend). In Figure 4-51d, this airspeed limit has been coupled with an exceedingly severe restriction on θ_F so that, even at cruise power, the aircraft descends with an excessive fuselage angle.

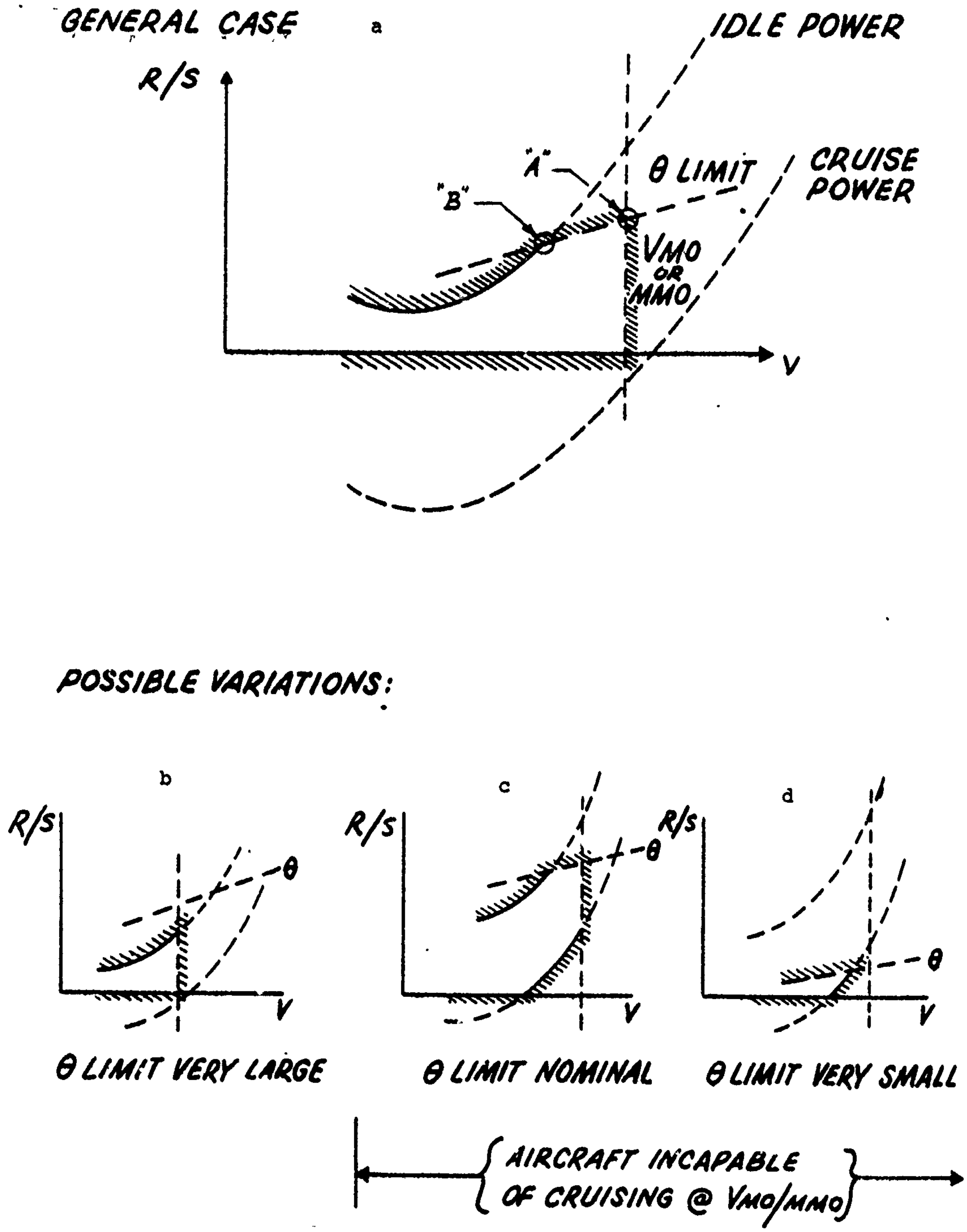


Figure 4-51. Descent Boundaries.

In the event of this most unlikely circumstance, the program will print out an error message and the case will terminate. For other than this condition (Figure 4-51d, the program will calculate the true airspeed, rate of sink, fuel consumption, and required power during the descent.

A distinction is made between the first two types of descent (maximum speed, flight idle) and the last two (constant EAS, Mach number) in regard to the range at which the descent starts if terminal range is specified. This distinction should be clearly understood.

a. If DESIND = 5 or 7, the descent will start at the current value for range and, as previously described, the airplane will fly a straight-line path to the desired terminal point. This may necessitate a "spiral" descent path. The descent may follow any other segment (climb, cruise, etc.) or may start the mission.

b. If DESIND = 1 or 3, no spiral descent path is permitted. The program will calculate the value for range at the beginning of the descent which is required to satisfy the terminal condition on range and altitude. In order to do this, the program "backs up" on the previous segment. If these options (1 and 3) are used, the descent must be preceded by a cruise segment. The input value for maximum range for the preceding cruise segment is a dummy value and the cruise will actually terminate, in order to begin descent, at an earlier point. It is recommended, however, that when descent options 1 or 3 are to be used, the maximum range during the preceding cruise be input as the same value as the terminal range at the end of the following descent.

Any of the descent options for which the terminal range is not specified may be used at any point in the program, following any other segment or at the beginning of the mission. The descent will start at the current value of range.

An increment in airplane drag coefficient may be input in order to simulate the effects of drag brakes.

Input to the subroutine consists of the limiting body angle, the final altitude, the step size (increment in altitude), the increment in drag coefficient, the setting for DESIND and, if required, the following

data: terminal range, required Mach number, and required EAS.

Figure 4-52 is a flow chart for this subroutine.

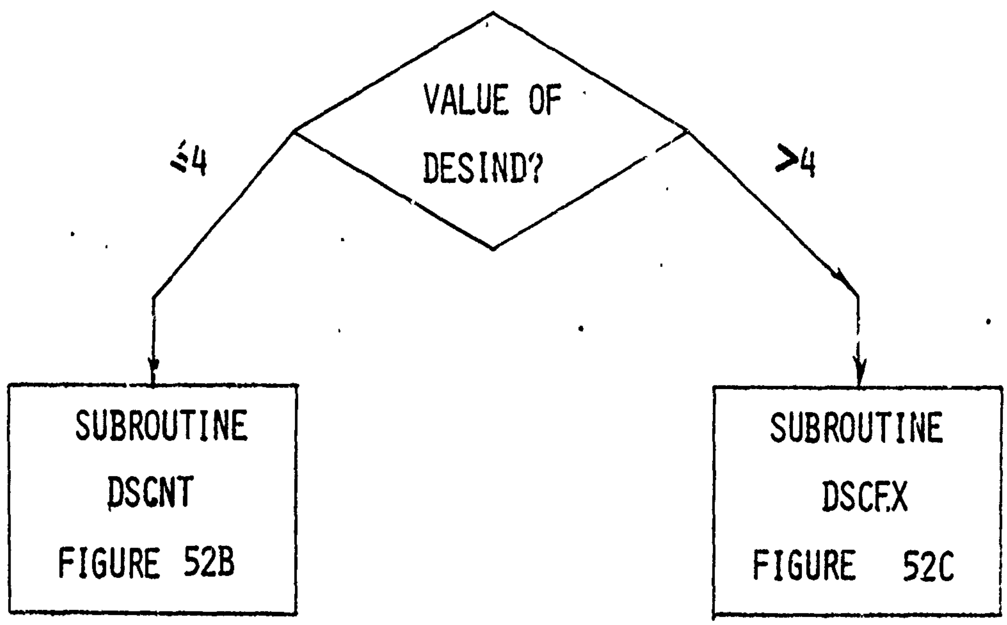
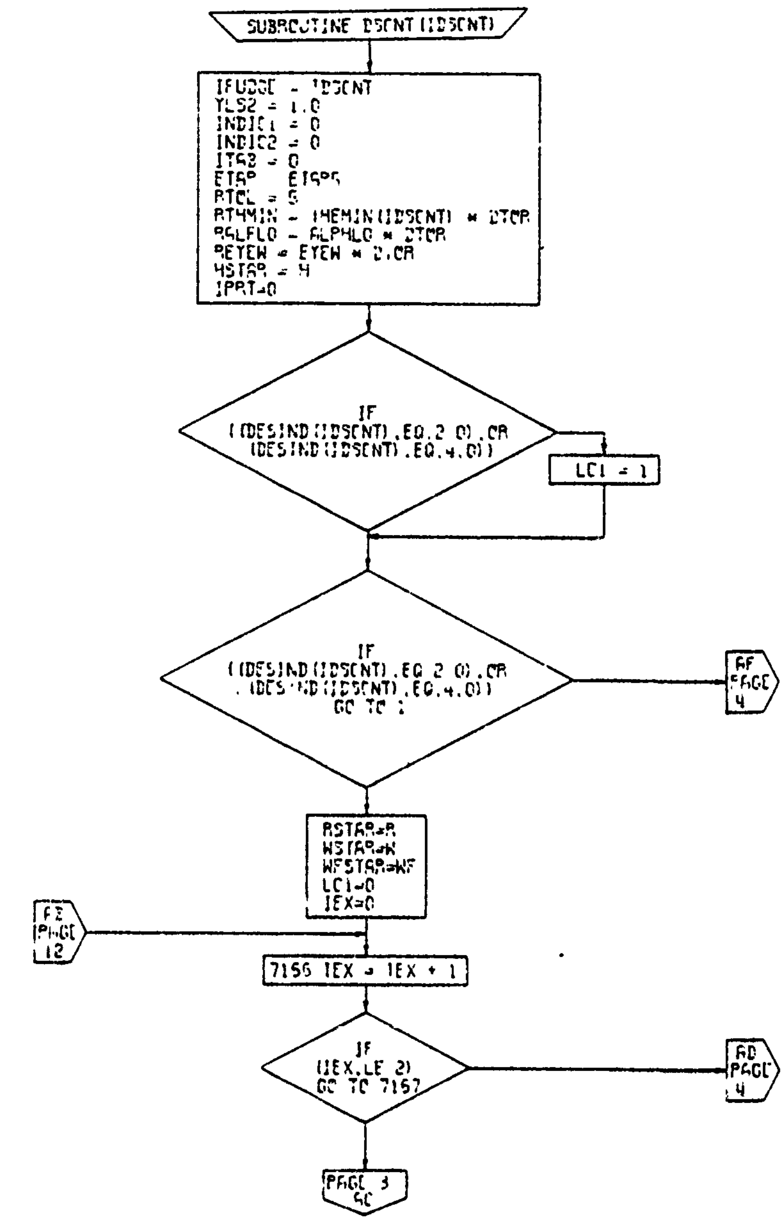


Figure 4-52a. Descent Calculations Subroutine, Program Flow



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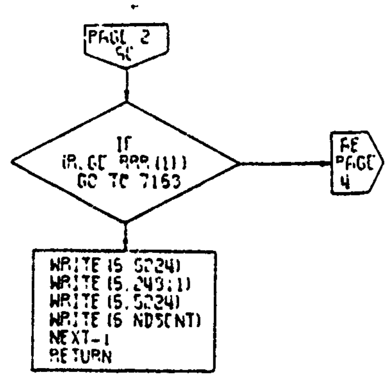

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Figure 52B, Descent Calculations Subroutine, Flow Chart (Part 1 of 14)

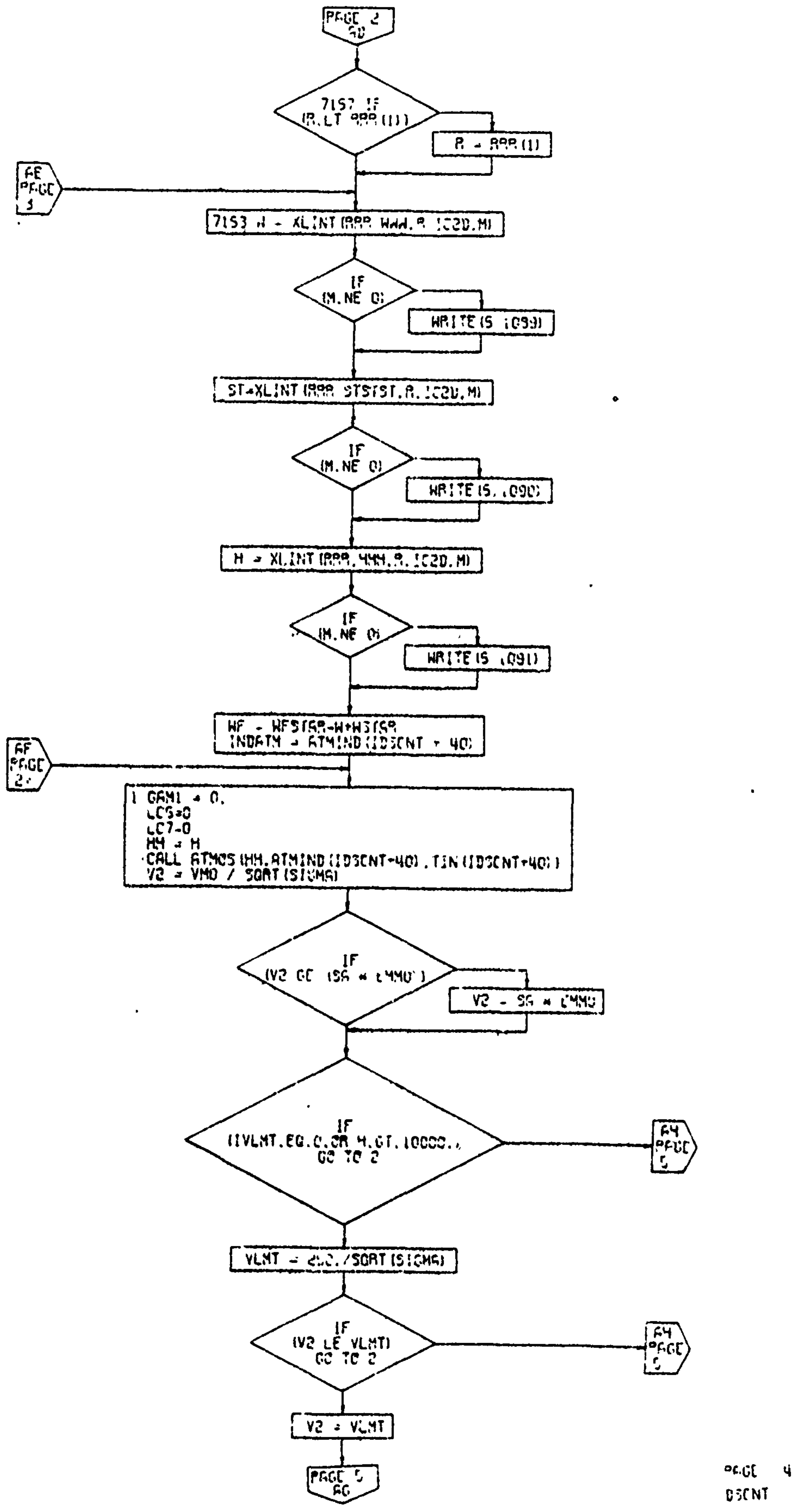

Figure 52B. Descent Calculations Subroutine, Flow Chart (Part 2 of 14)

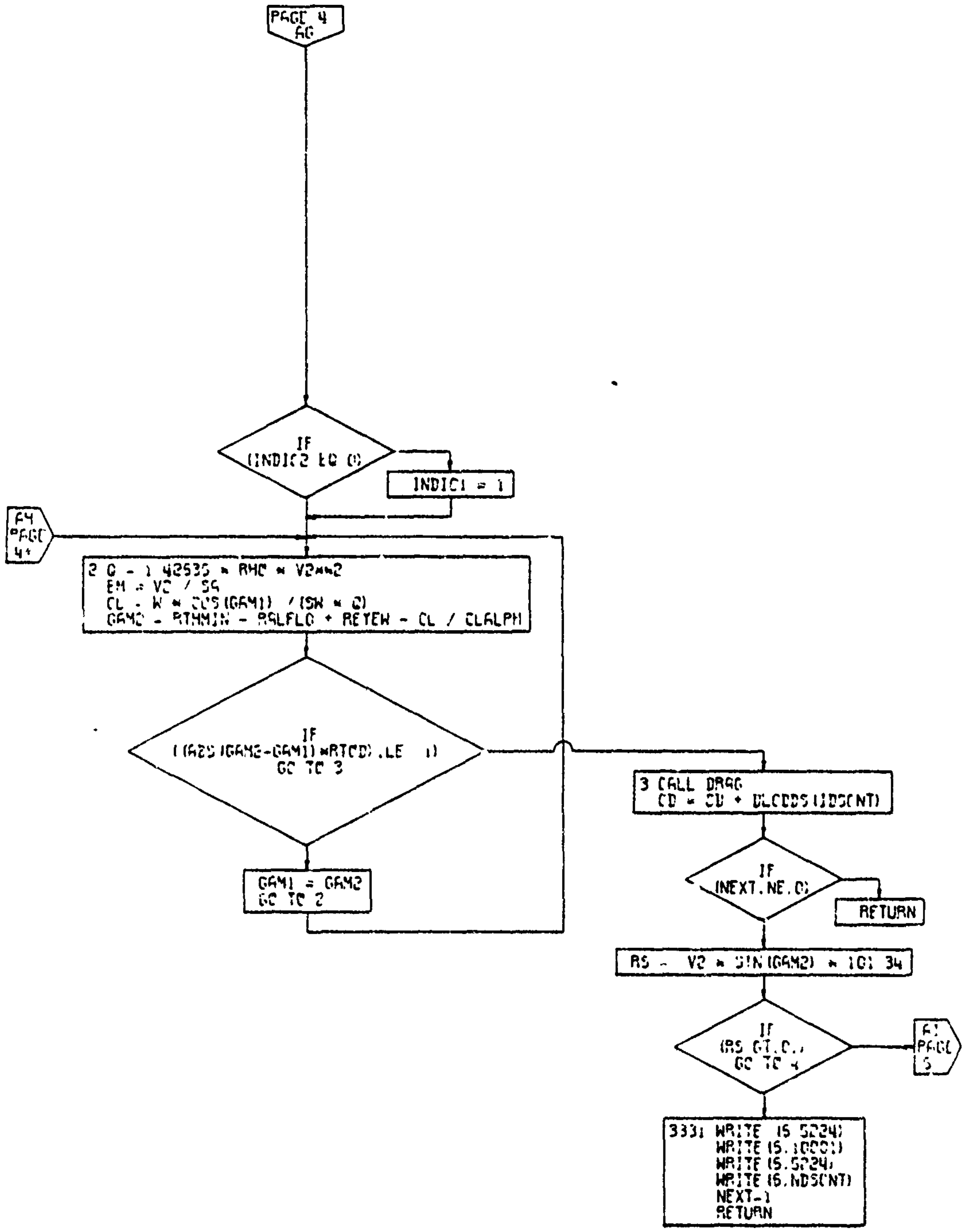

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Figure 52B. Descent Calculations Subroutine, Flow Chart (Part 3 of 14)

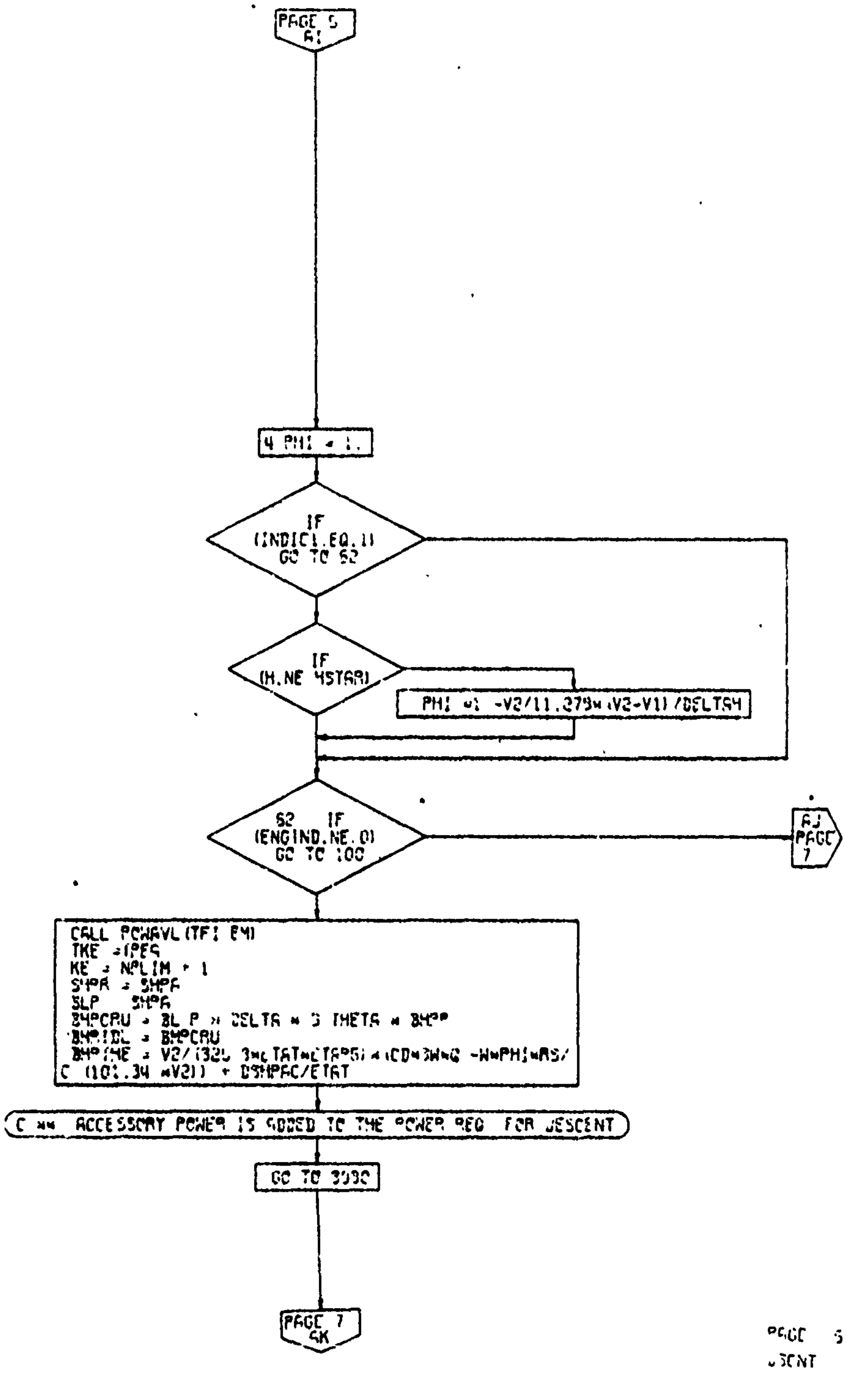

Figure 52B. Descent Calculations Subroutine, Flow Chart (Part 4 of 14)

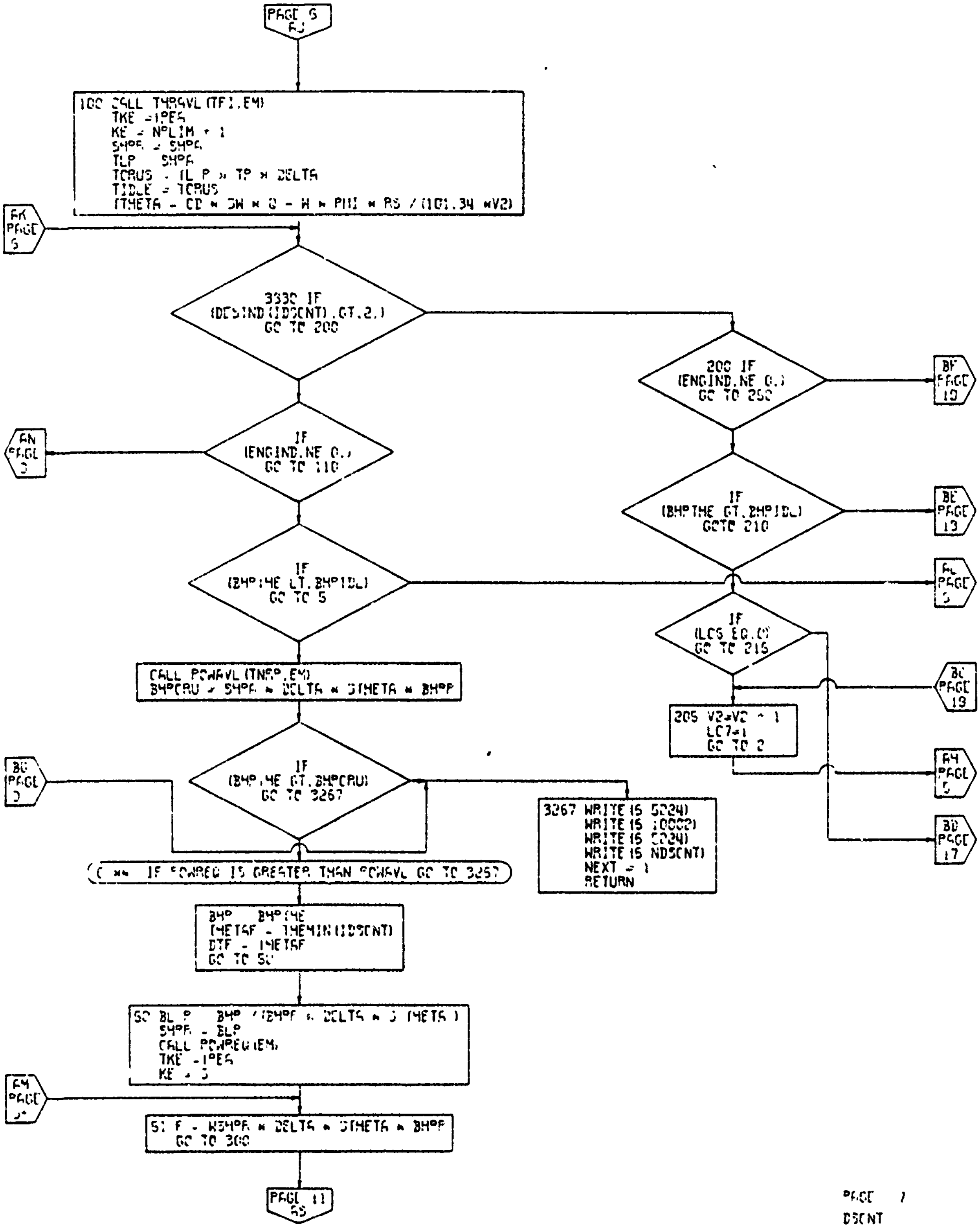

Figure 52B. Descent Calculations Subroutine, Flow Chart (Part 5 of 14)

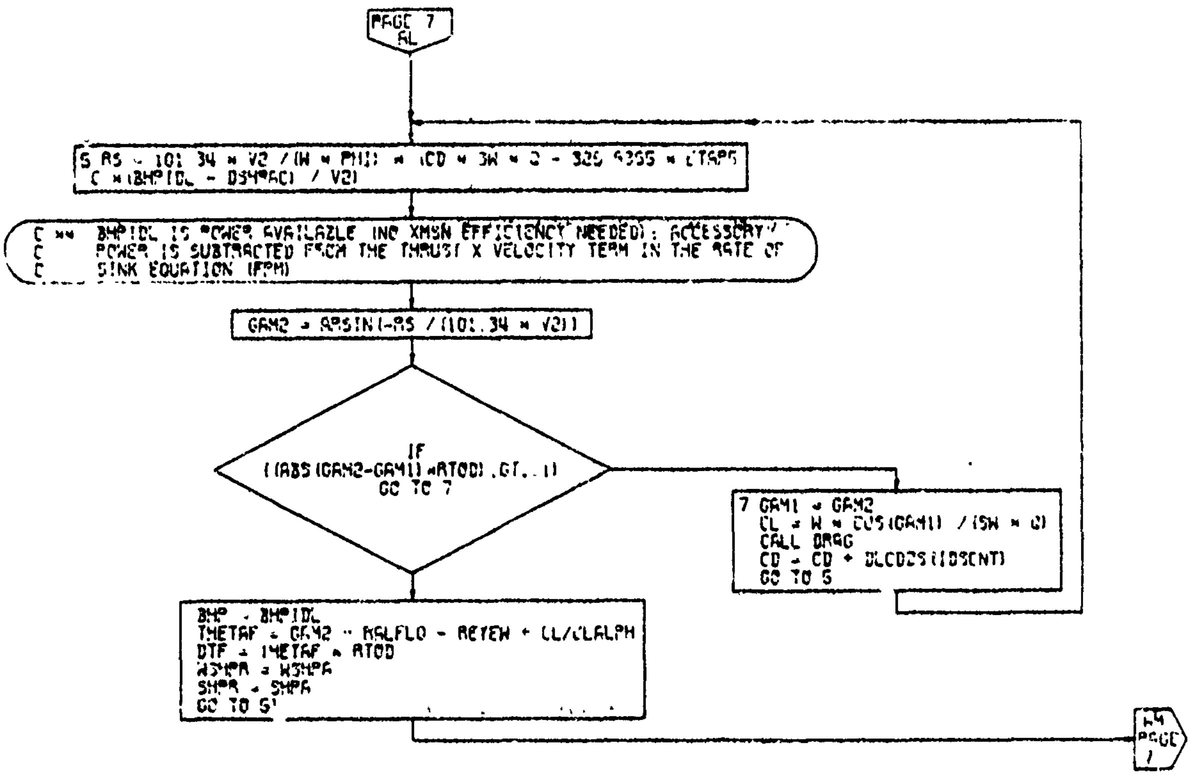

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Figure 52B. Descent Calculations Subroutine,
Flow Chart (Part 6 of 14)

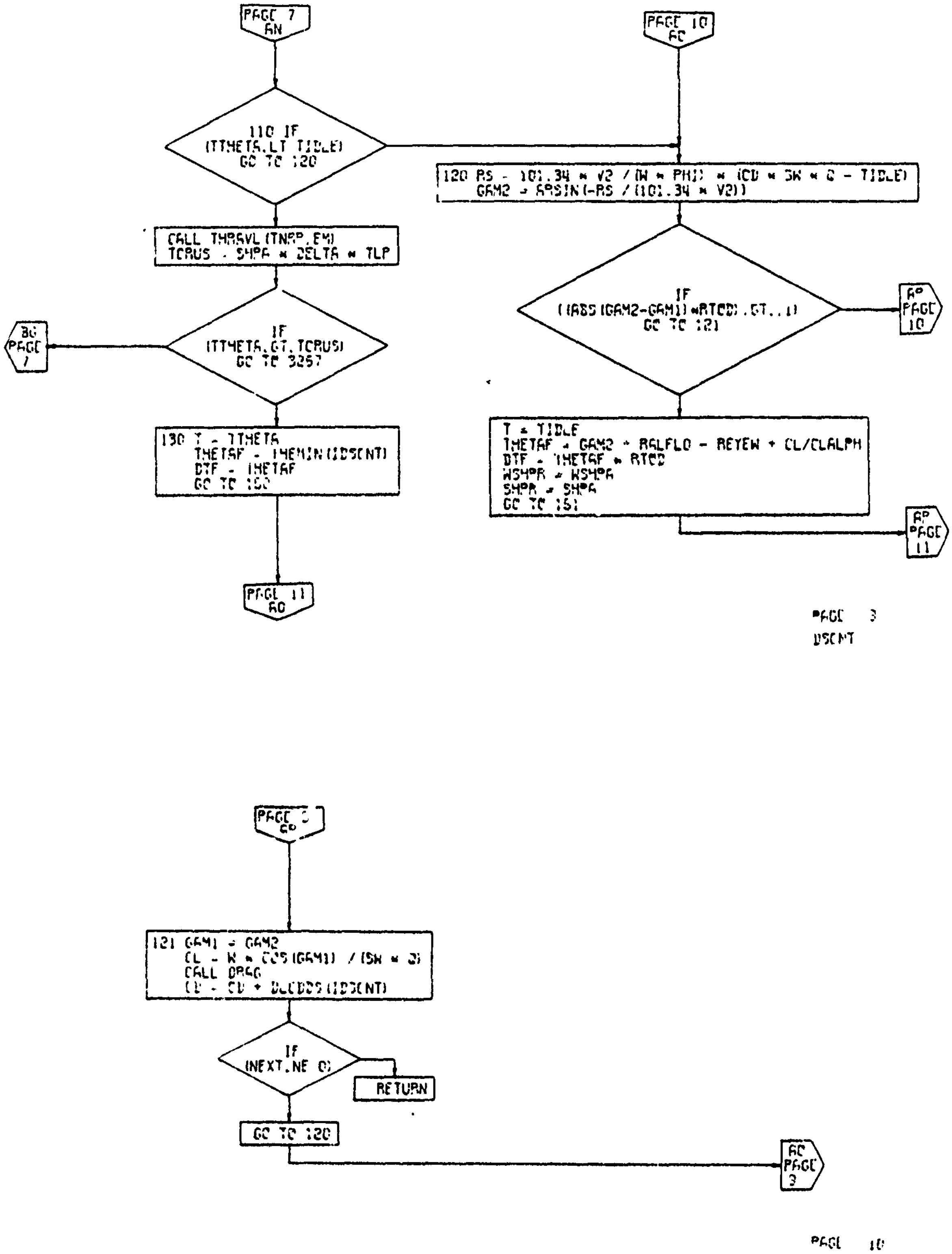

Figure 52B. Descent Calculations Subroutine, Flow Chart (Part 7 of 14)

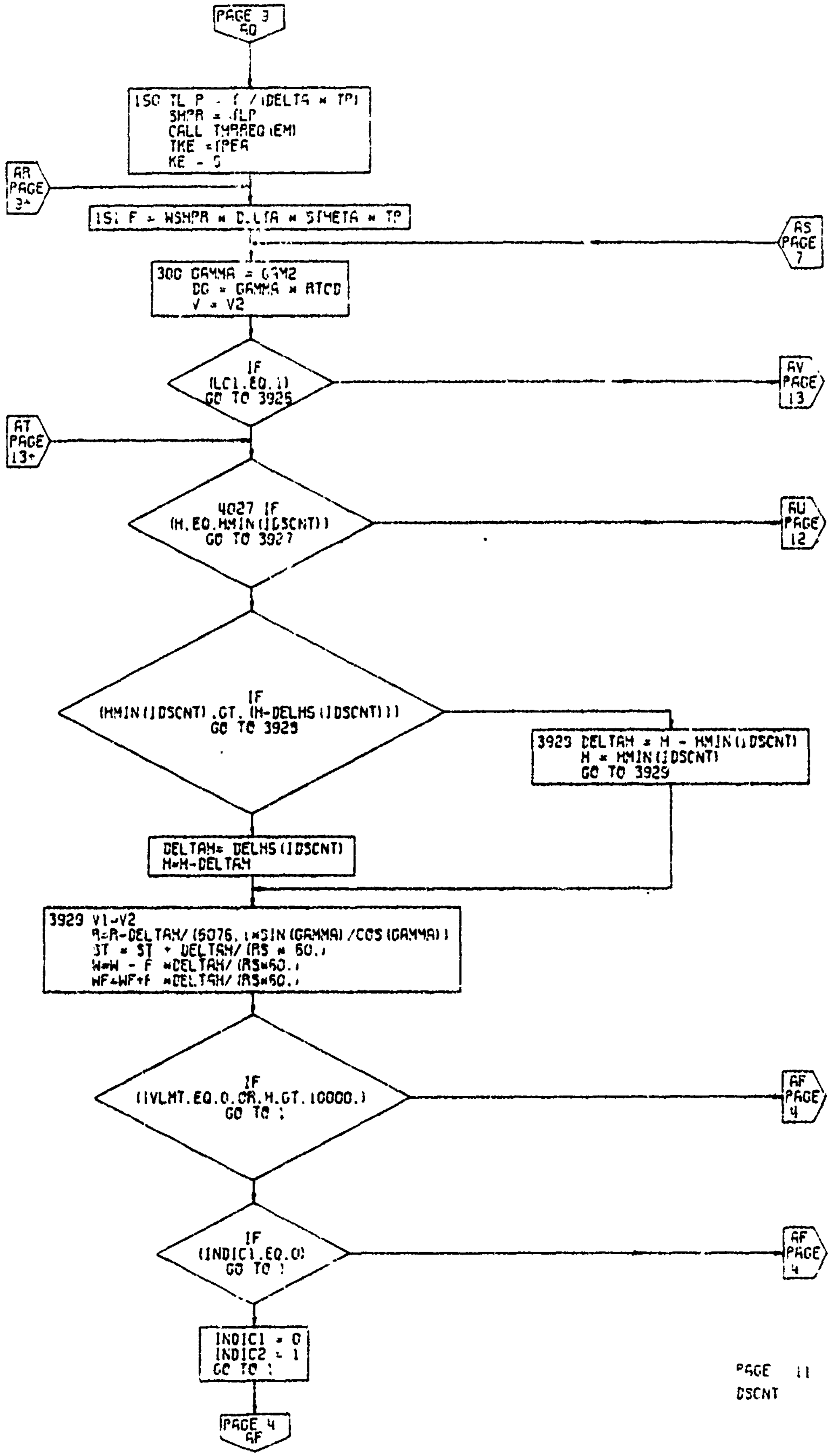

Figure 52B. Descent Calculations Subroutine, Flow Chart (Part 8 of 14)

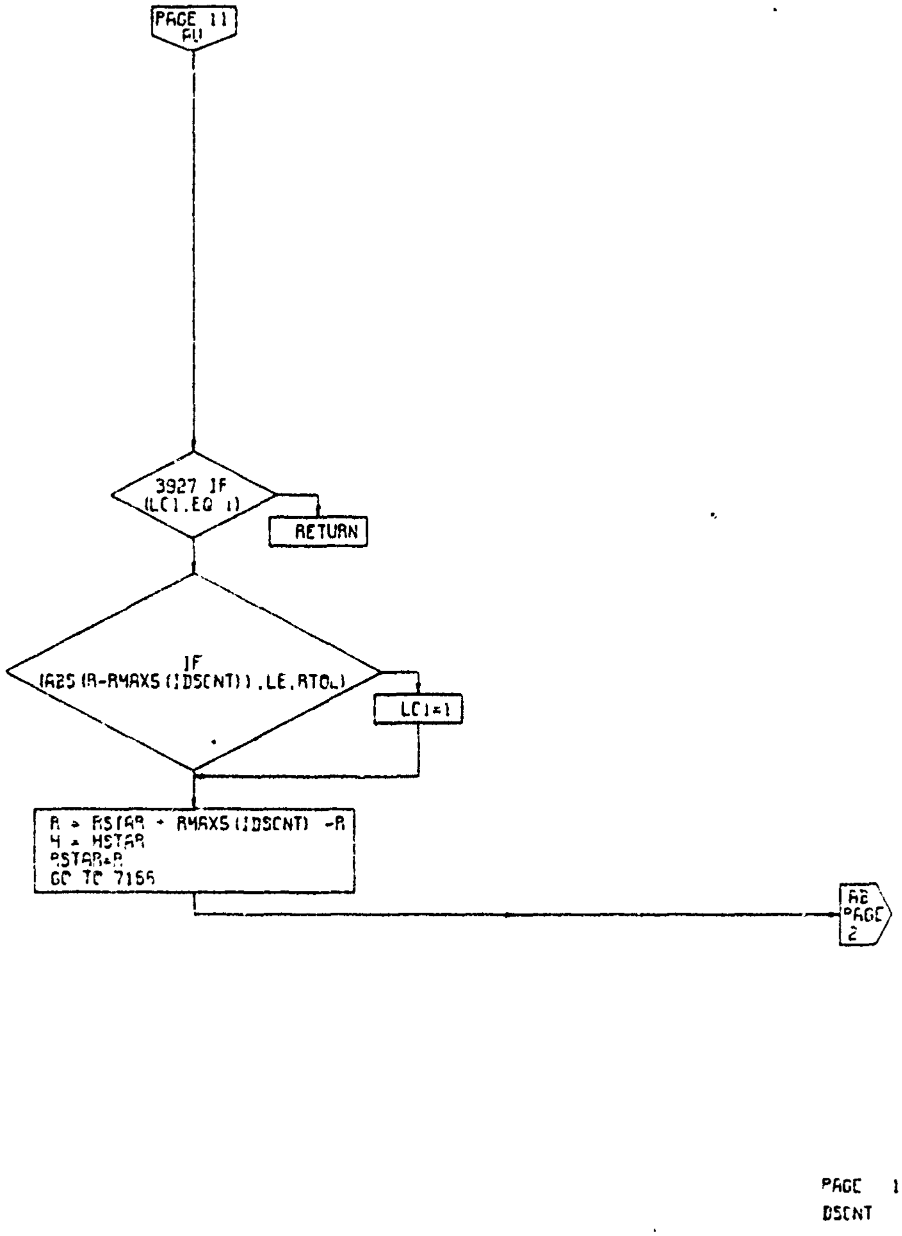

Figure 52B. Descent Calculations Subroutine, Flow Chart (Part 9 of 14)

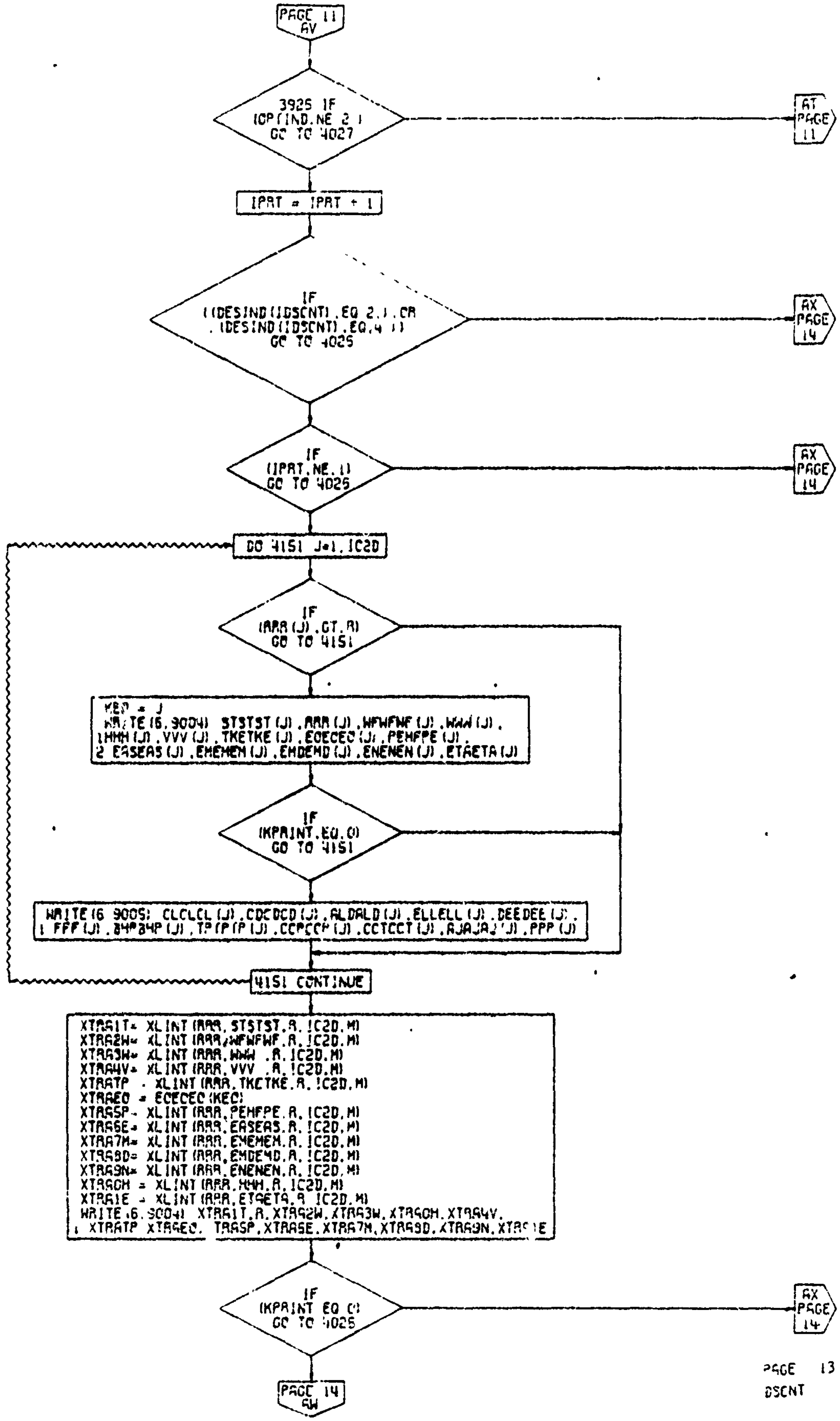

Figure 52B. Descent Calculations Subroutine, Flow Chart (Part 10 of 14)

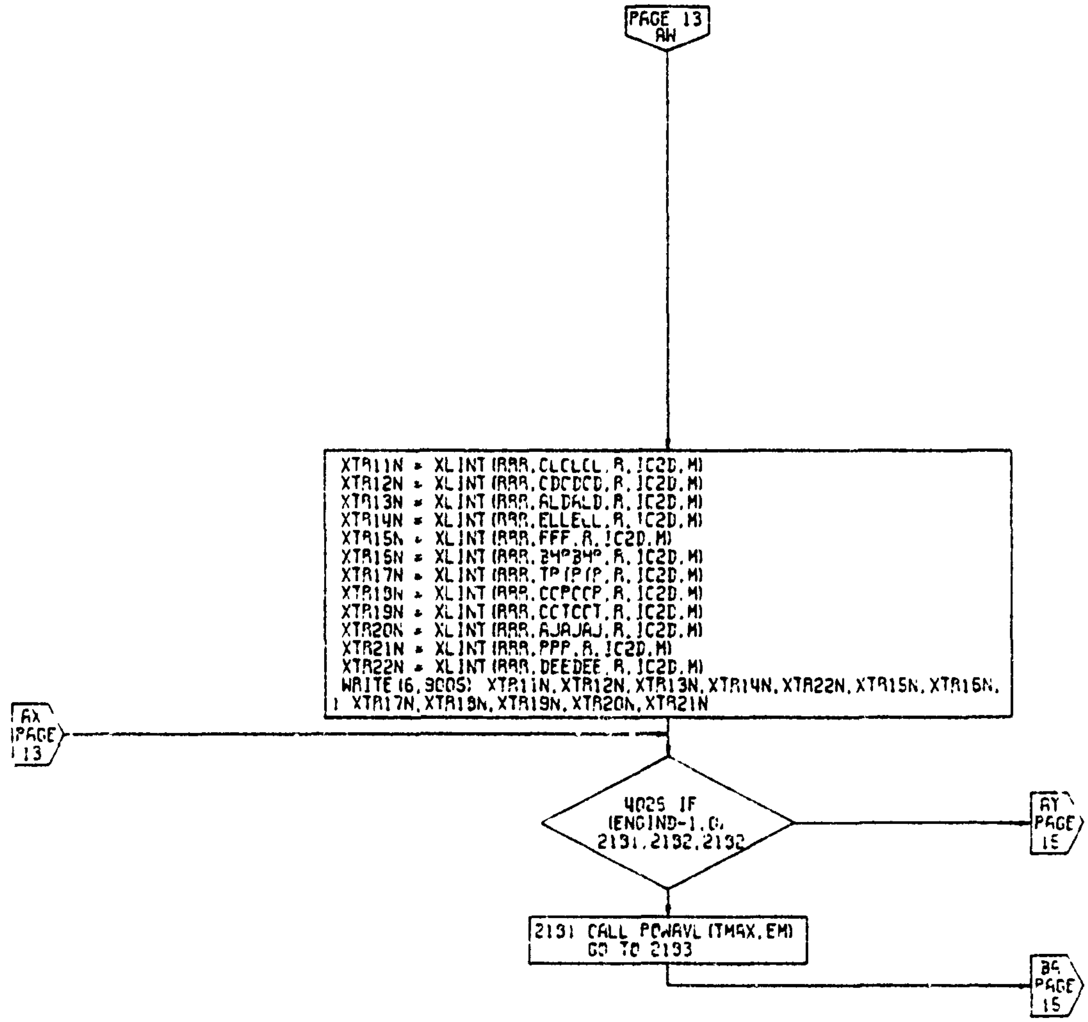

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Figure 52B. Descent Calculations Subroutine, FlowChart (Part 11 of 14)

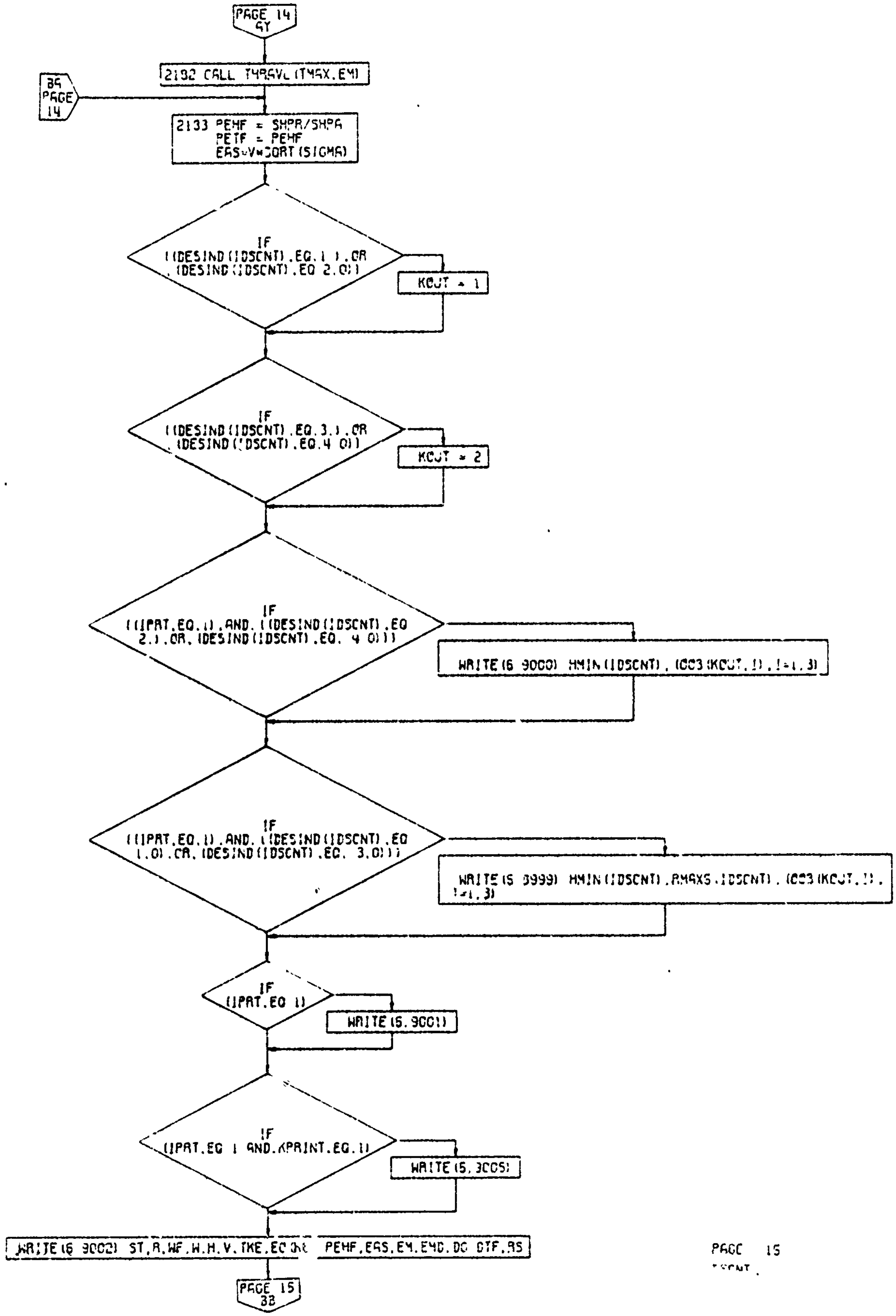
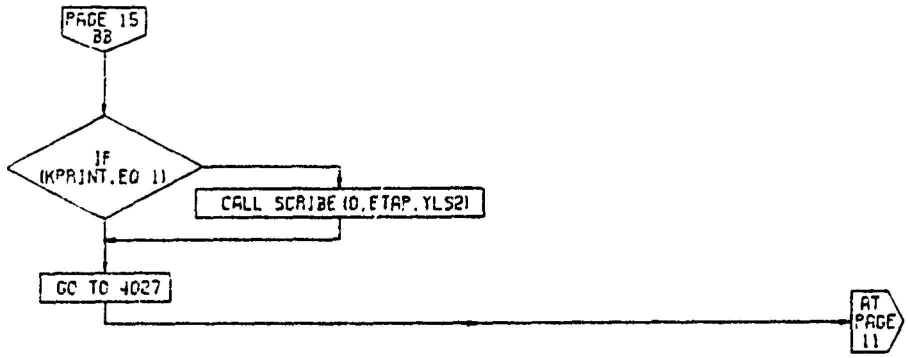


Figure 52B. Descent Calculations Subroutine, Flow Chart (Part 12 of 14)



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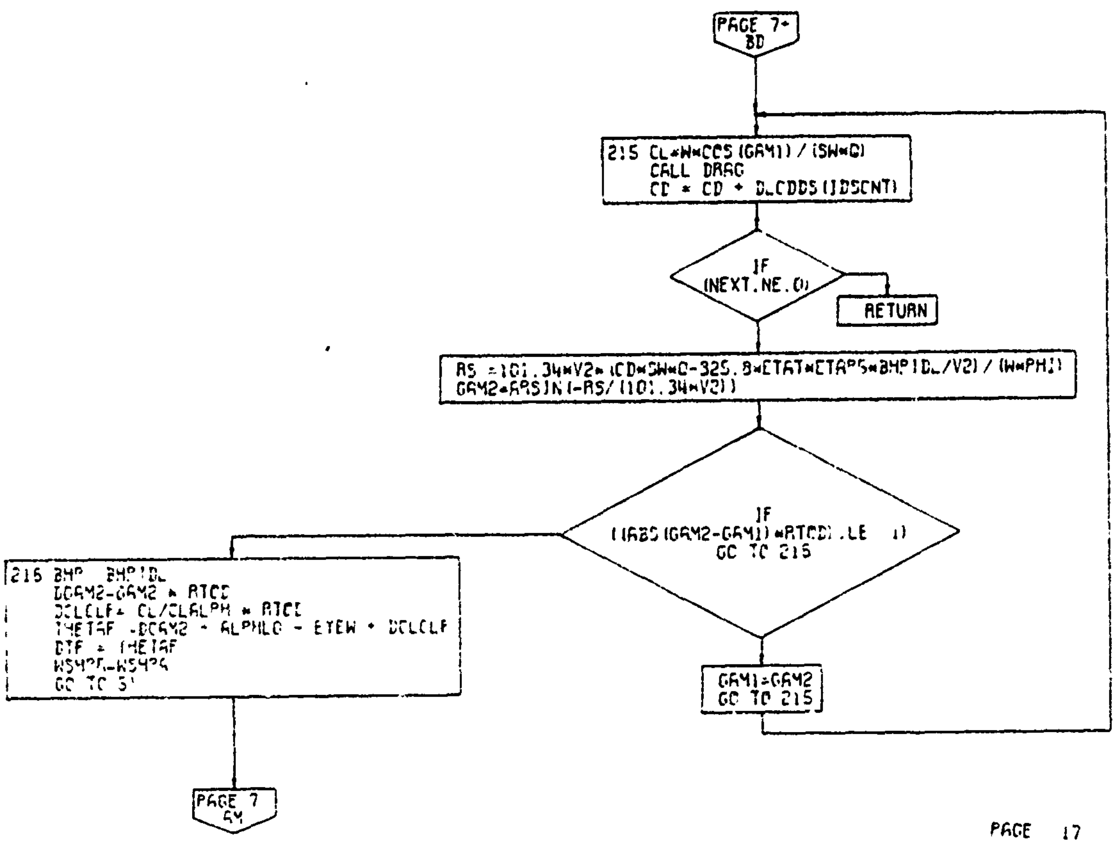

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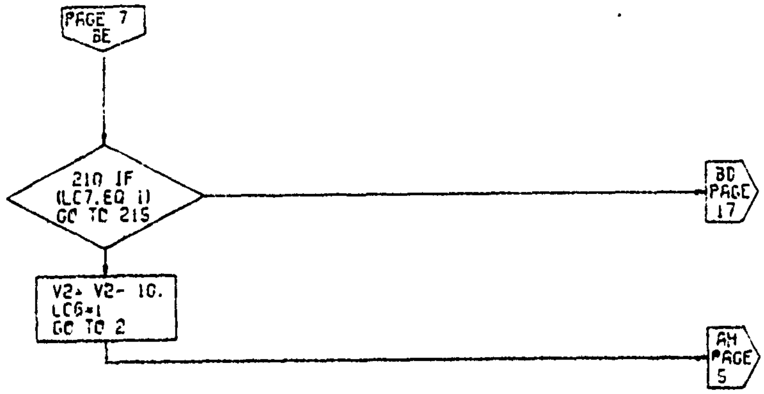
Figure 52B . Descent Calculations Subroutine,
Flow Chart (Part 13 of 14)



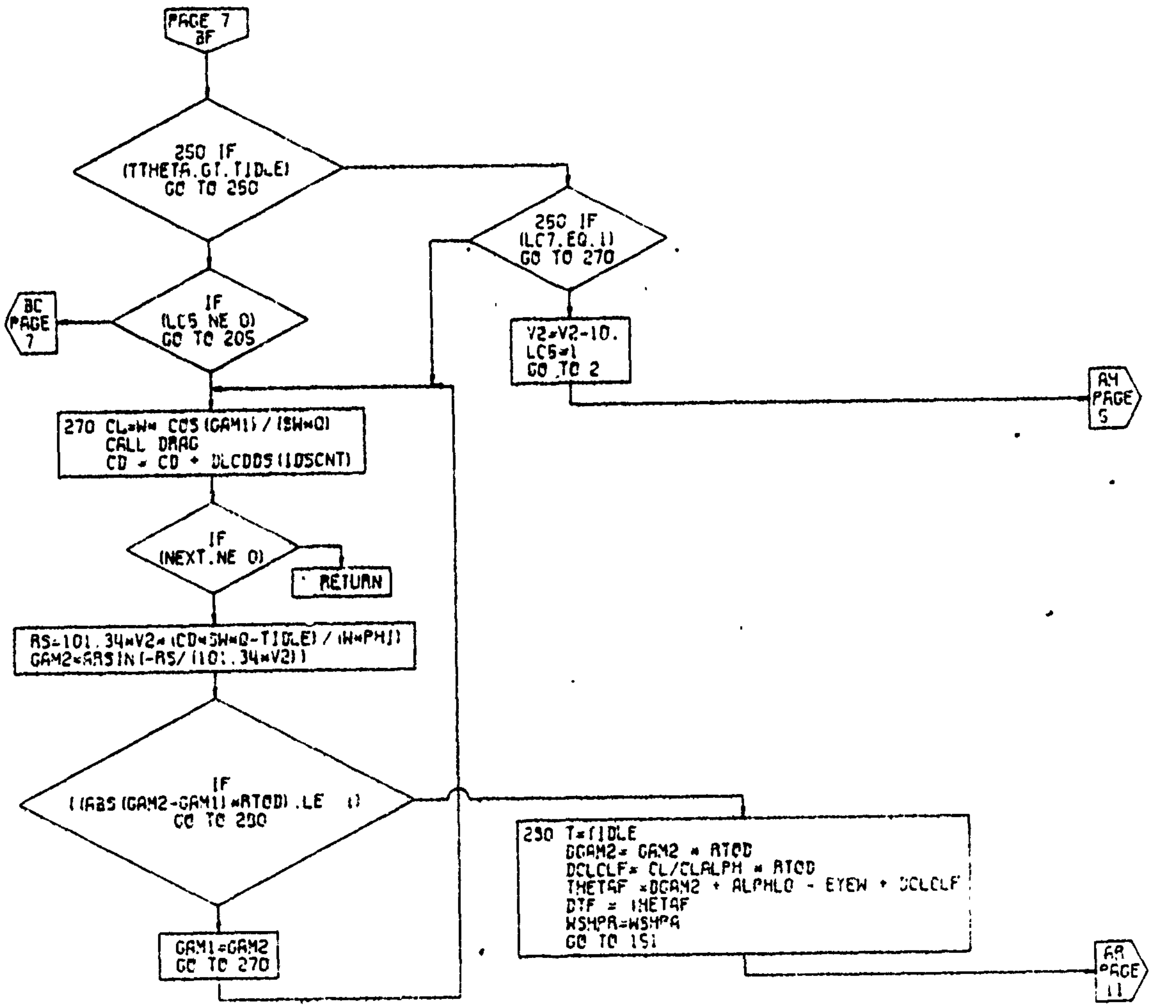


Figure 52B. Descent Calculations Subroutine, Flow Chart (Part 14 of 14)

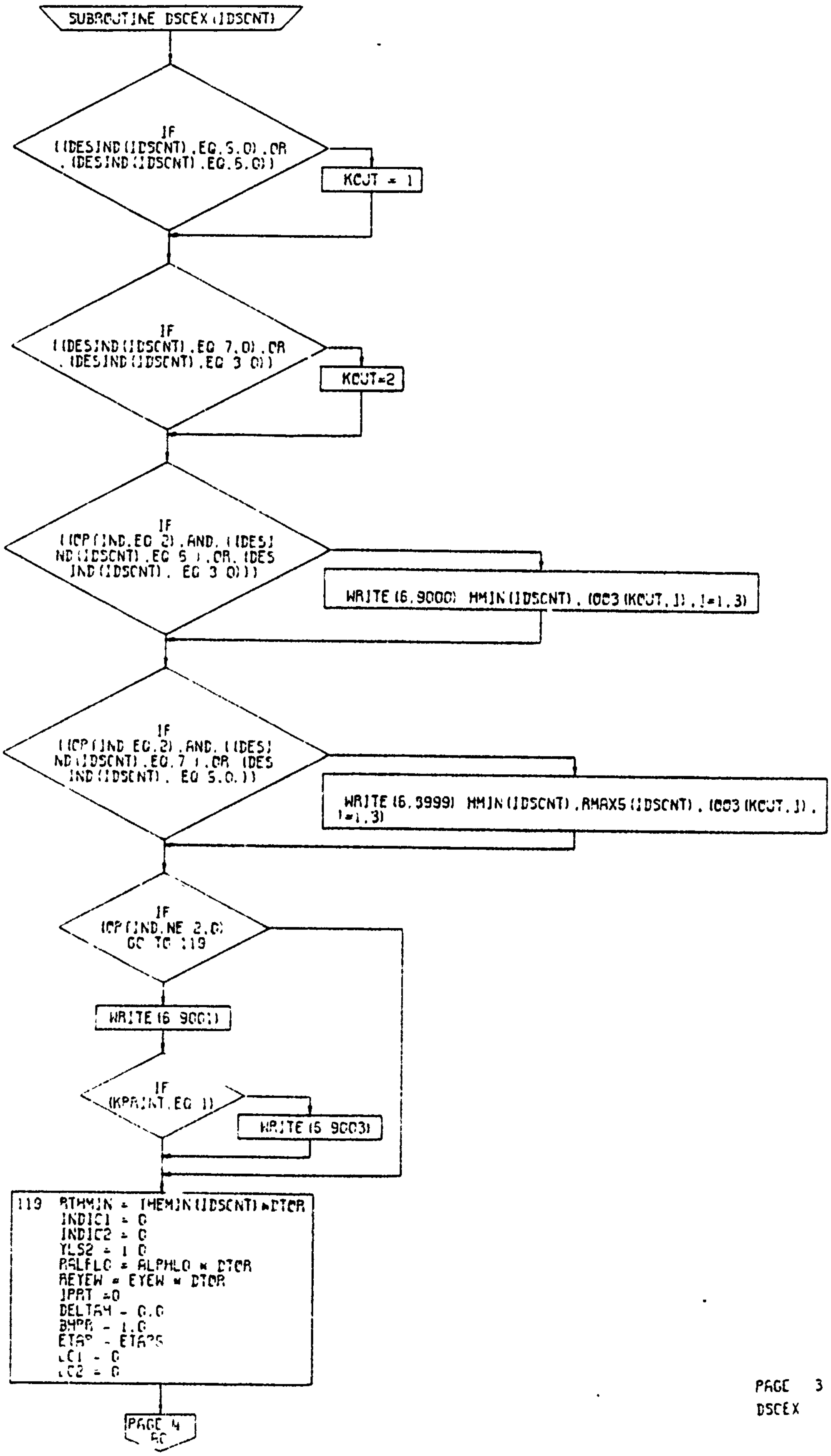


Figure 52C DSCEX Calculations Subroutine, Flow Chart (Part 1 of 9)

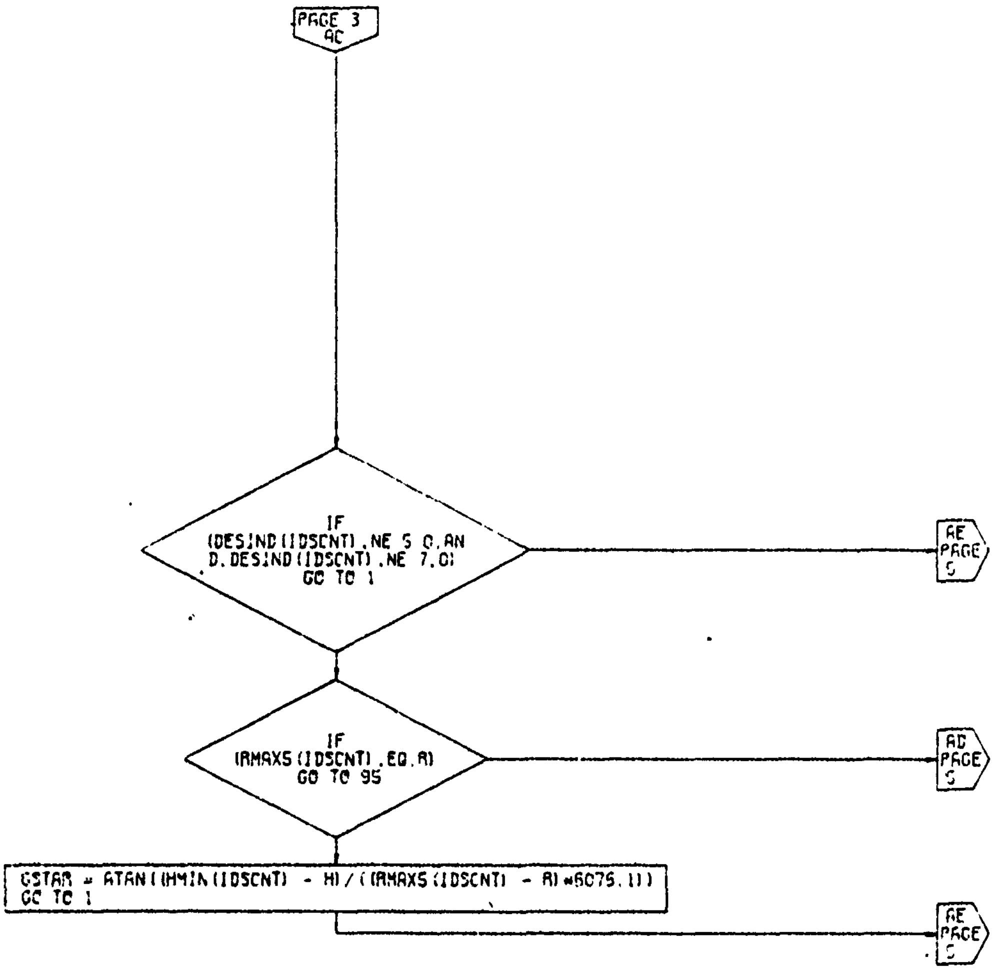


Figure 52C, DSCEX Calculation Subroutine, Flow Chart (Part 2 of 9)

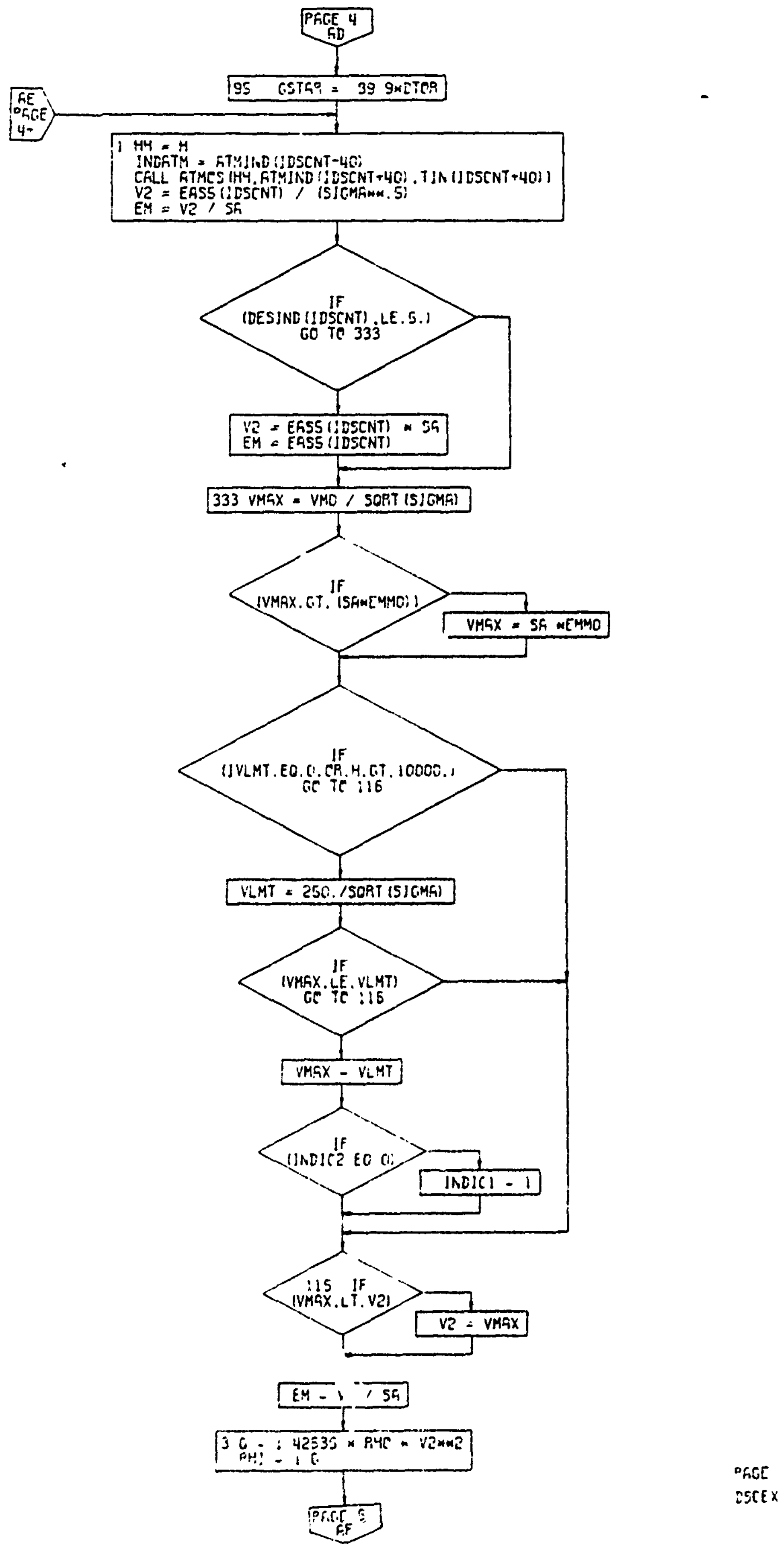


Figure 52C. DSCEX Calculations Subroutine, Flow Chart (Part 3 of 9)

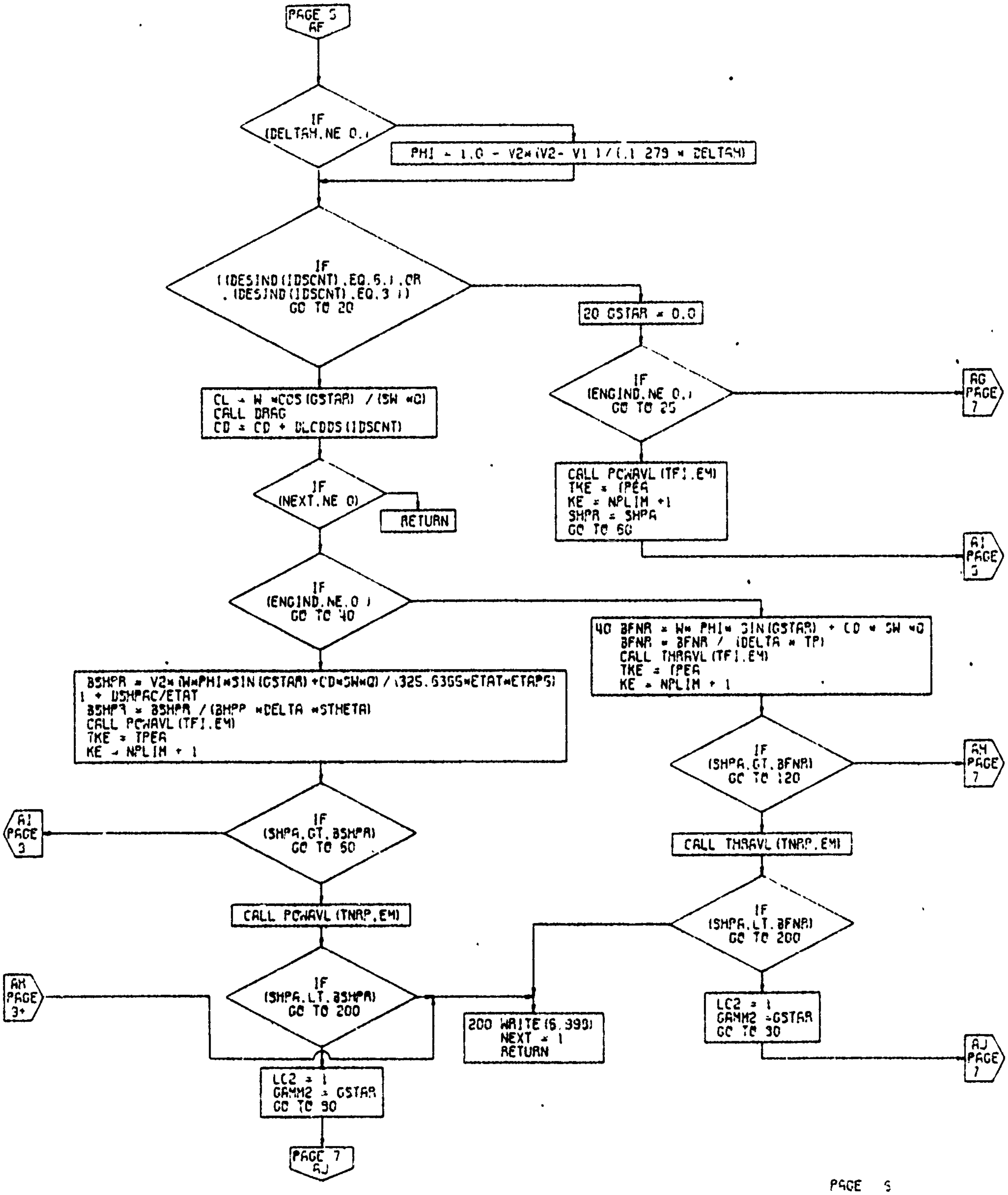


Figure 52C. DSCEX Calculations Subroutine, Flow Chart (Part 4 of 9)

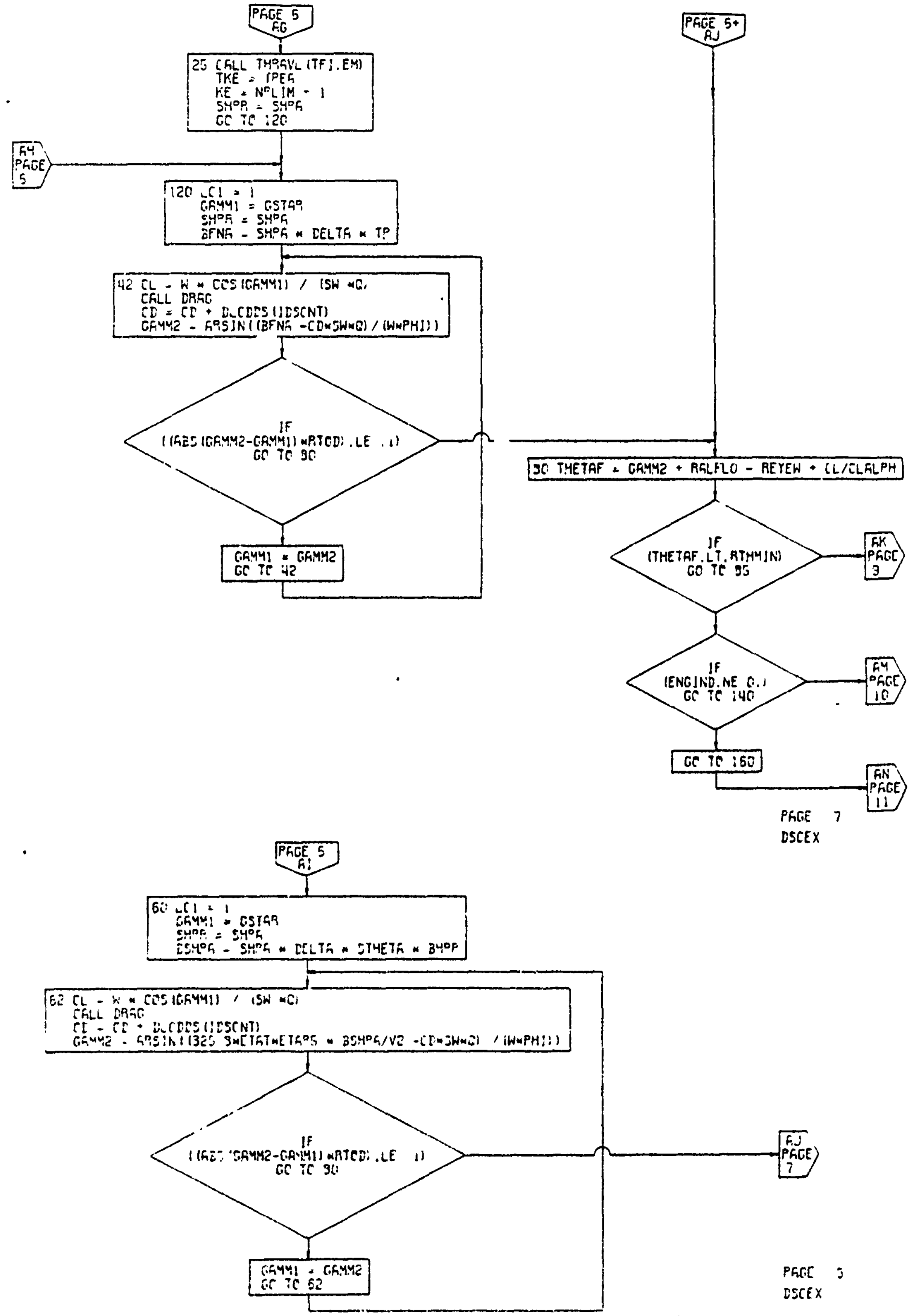


Figure 52C. DSCEX Calculations Subroutine, Flow Chart. (Part 5 of 9)

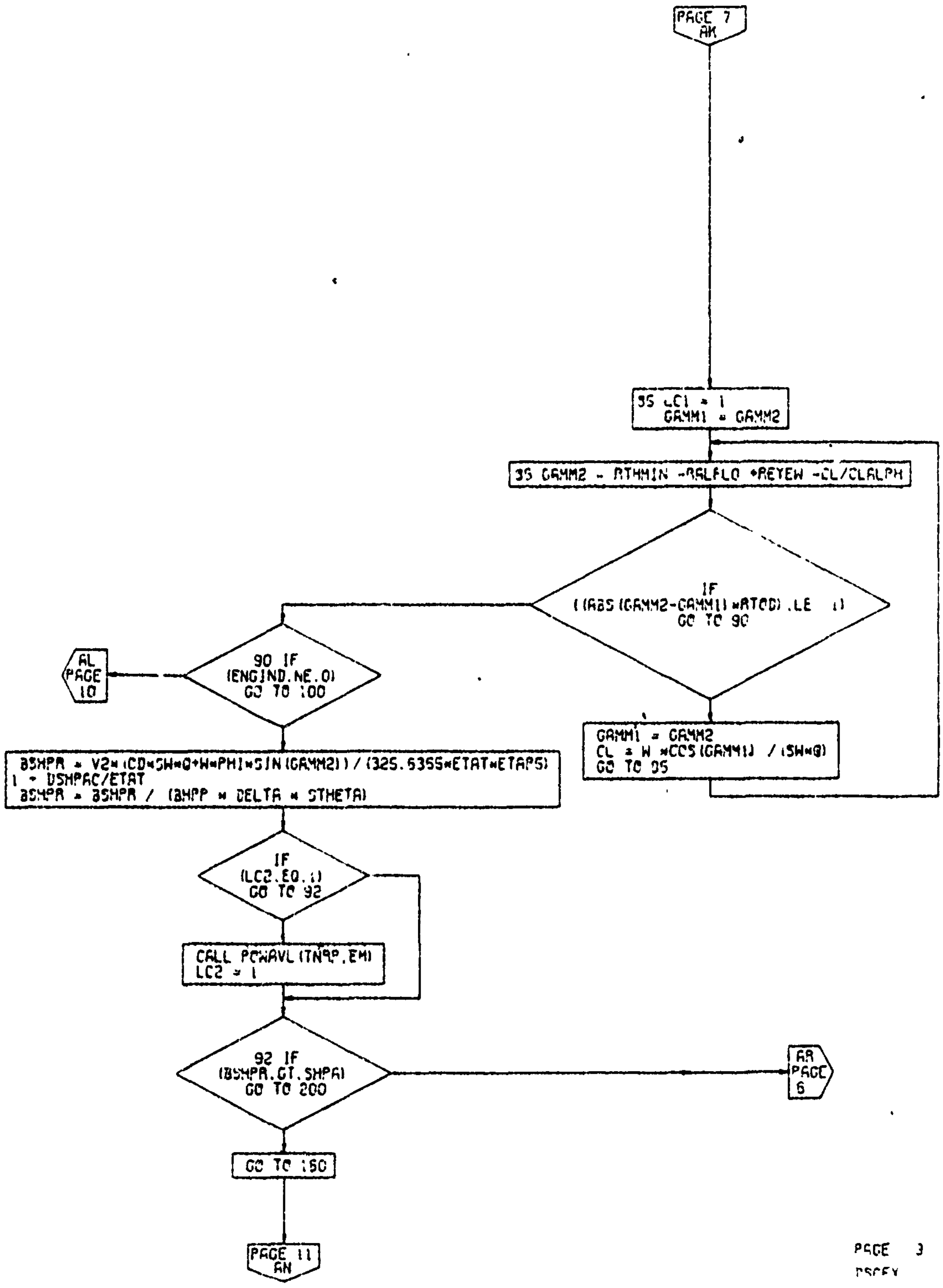


Figure 52C, DSCEX Calculations Subroutine, Flow Chart (Part 6 of 9)

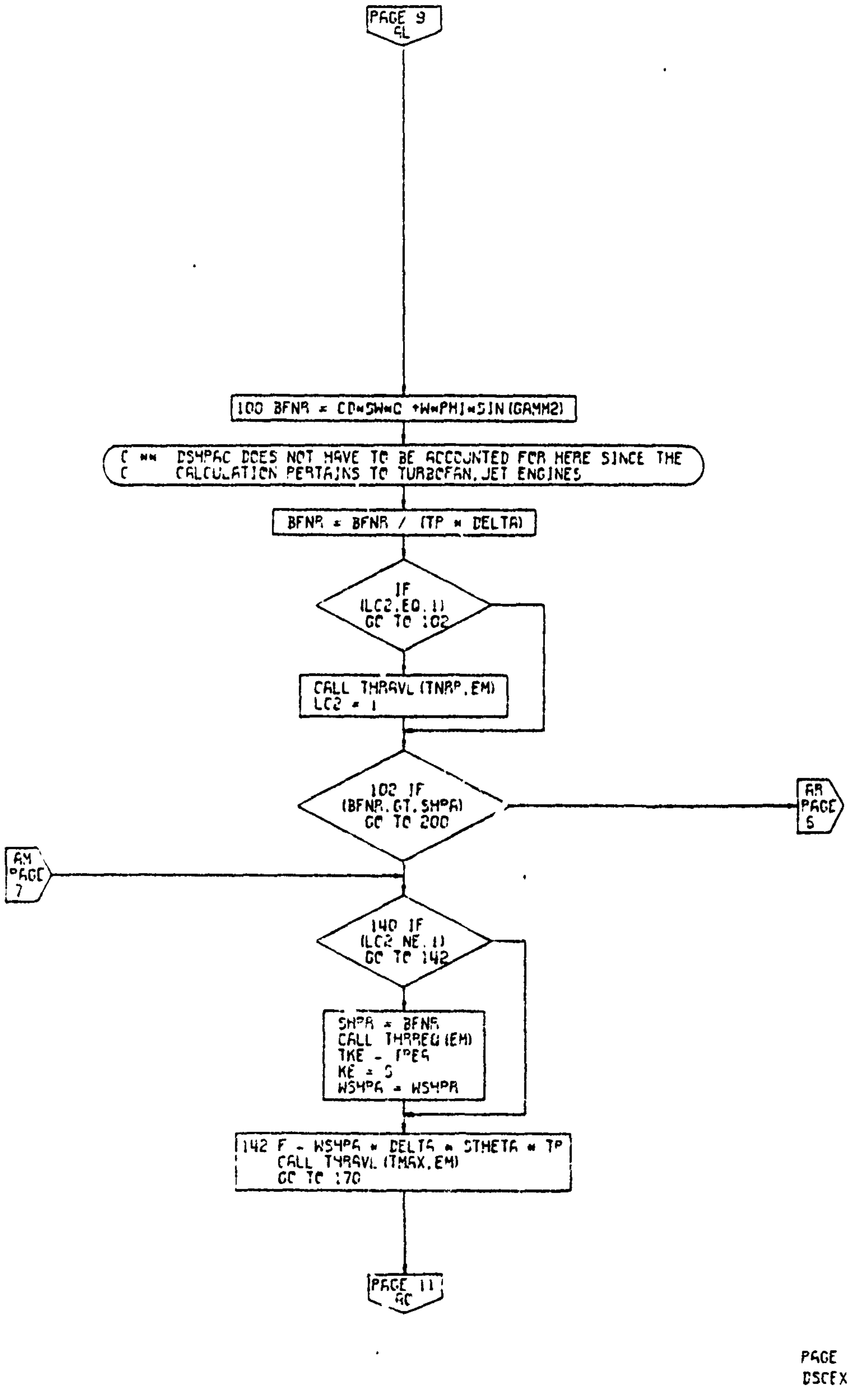


Figure 52C. DSCEX Calculations Subroutine, Flow Chart (Part 7 of 9)

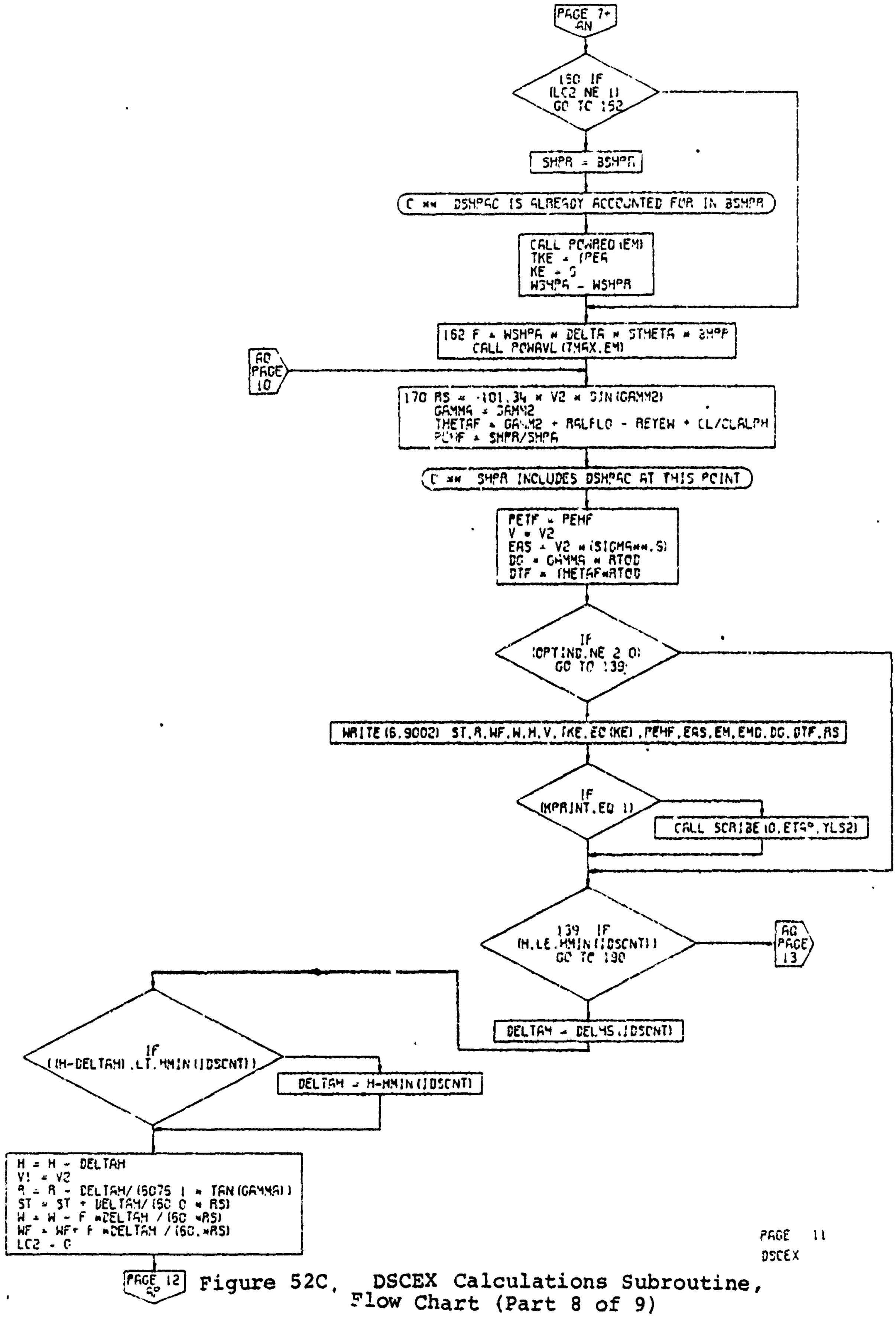
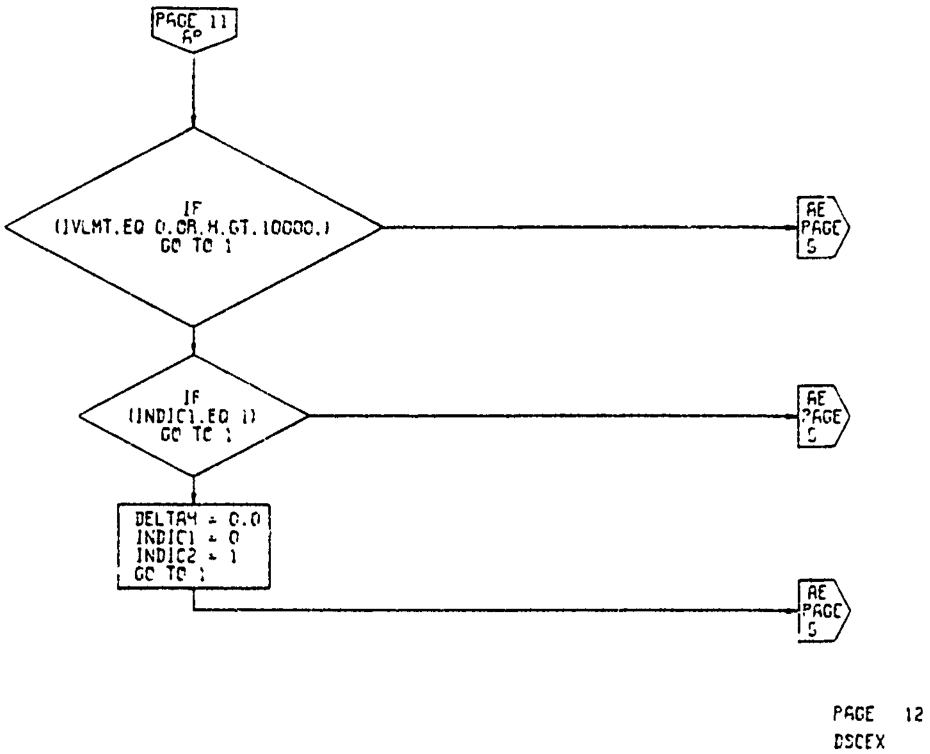


Figure 52C, DSCEX Calculations Subroutine, Flow Chart (Part 8 of 9)



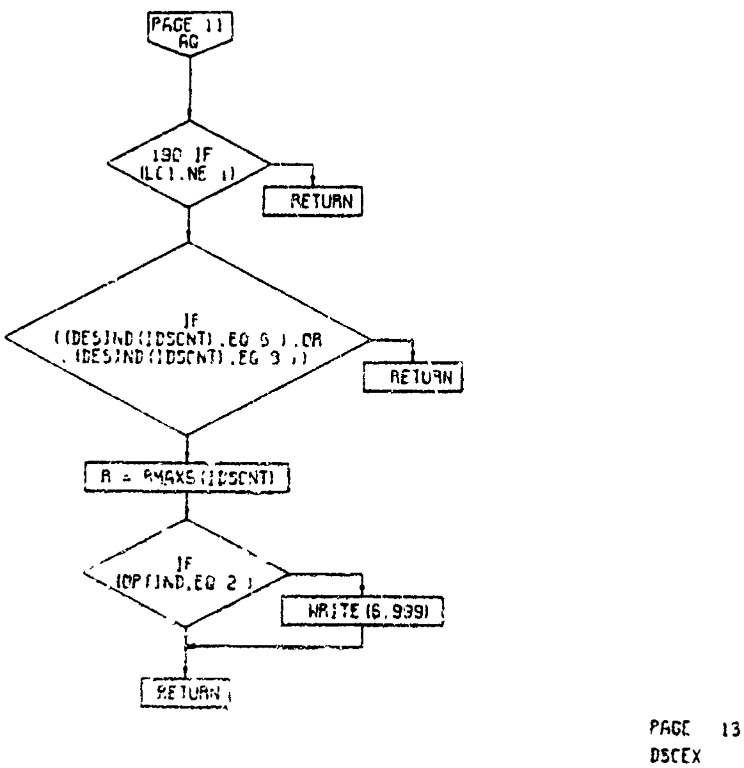


Figure 52C. DSCEX Calculations Subroutine, Flow Chart (Part 9 of 9)

4.10.6 Loiter Calculations Subroutine

The sixth performance segment represents a calculation of aircraft loiter performance. In this subroutine, the aircraft will fly at the airspeed for best endurance. This subroutine calculates the power required and the airspeed to maximize the endurance of the aircraft. It also determines the fuel required to loiter for a specified period of time.

If the limiting speed option (V_{LIM}IND=1) is used, the program will monitor the loiter speed at altitudes of 10,000 feet or less to ensure that the speed is less than 250 knots equivalent airspeed.

It is possible to use a loiter segment in the mission profile to account for a reserve fuel requirement (in which case the aircraft weight at the end of loiter is set back to the weight at the beginning of loiter) or as a part of the basic mission (in which case the weight is not reset). In either case, the fuel used during loiter is included in the total fuel required to size the aircraft. A loiter indicator, LTRIND, specifies to the program which option is being used. If LTRIND is input as zero, the loiter fuel will be included as part of the reserve fuel. If LTRIND is input as unity, the loiter fuel will be included as part of the mission fuel.

An engine shutdown during loiter may be simulated by an input for N_{PSD}. One or more engines may be shut down. An increment in drag coefficient ($\Delta C_{D\ LOITER}$) may be input to represent drag changes due to external stores or flaps.

Input to this subroutine consists of the value of LTRIND, the time for loiter, step size (incremental time), the incremental drag coefficient, the number of engines shut down, and the atmospheric conditions. A flow chart of this subroutine is shown in Figure 4-53.

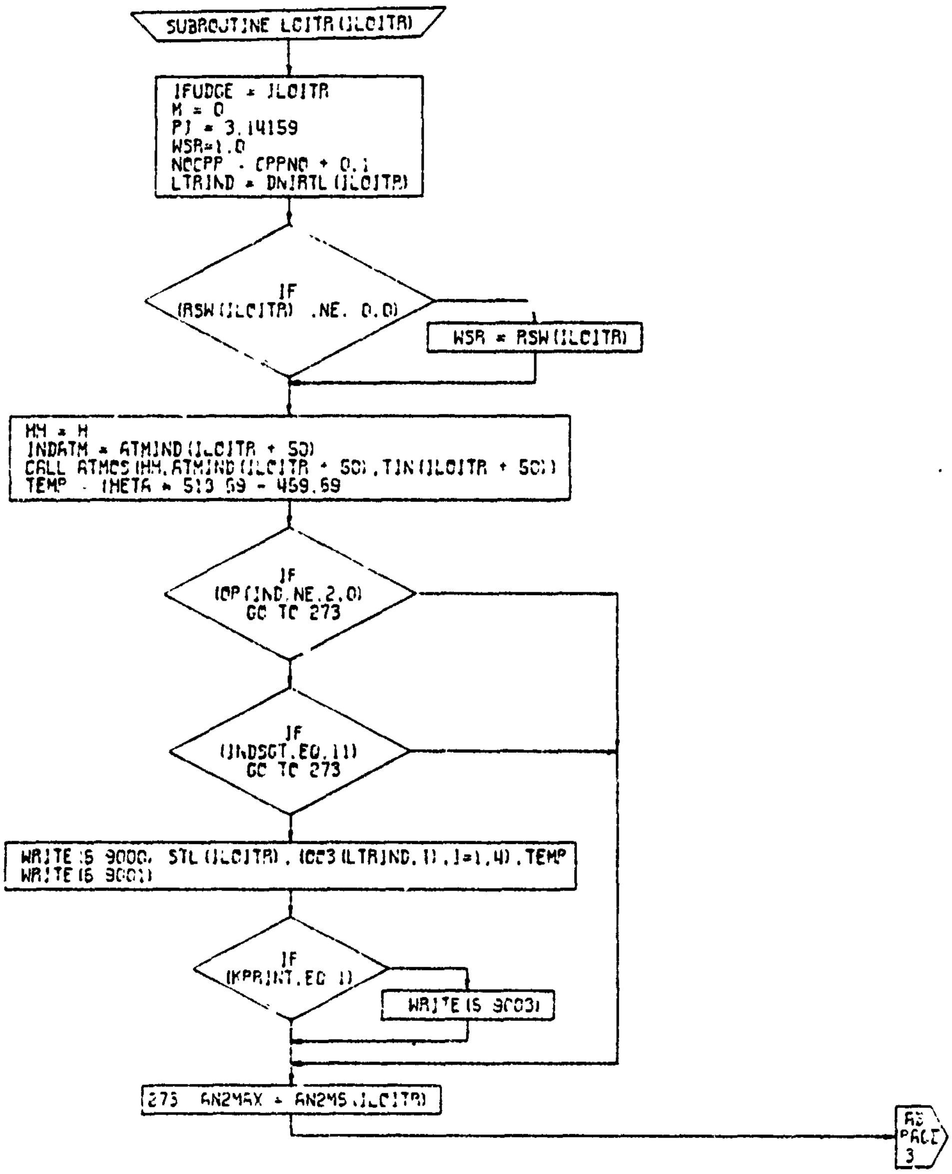


Figure 4-53. LOITER Calculations Subroutine, Flow Chart (Part 1 of 11)

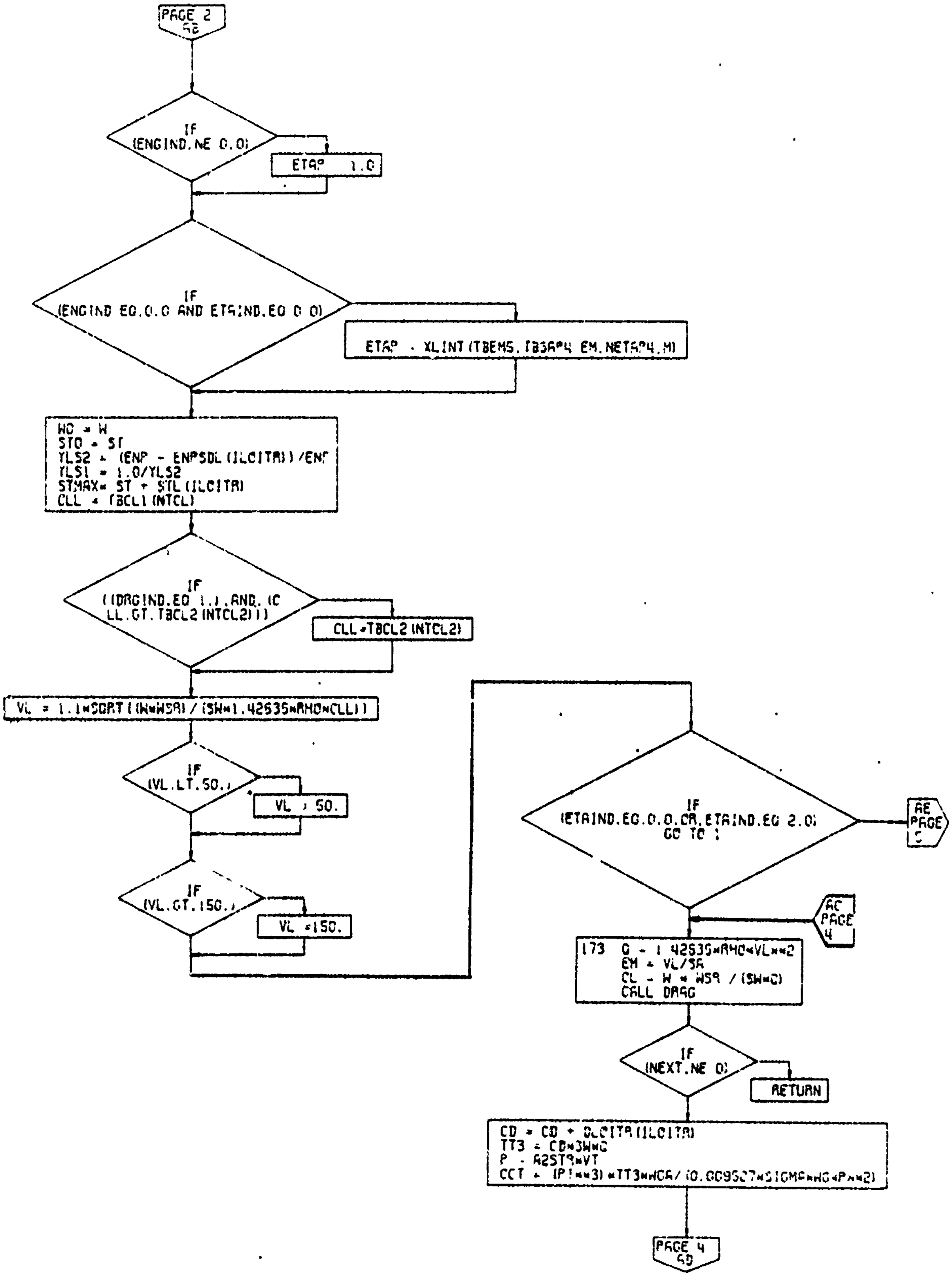


Figure 4-53. LOITER Calculations Subroutine, Flow Chart (Part 2 of 11)

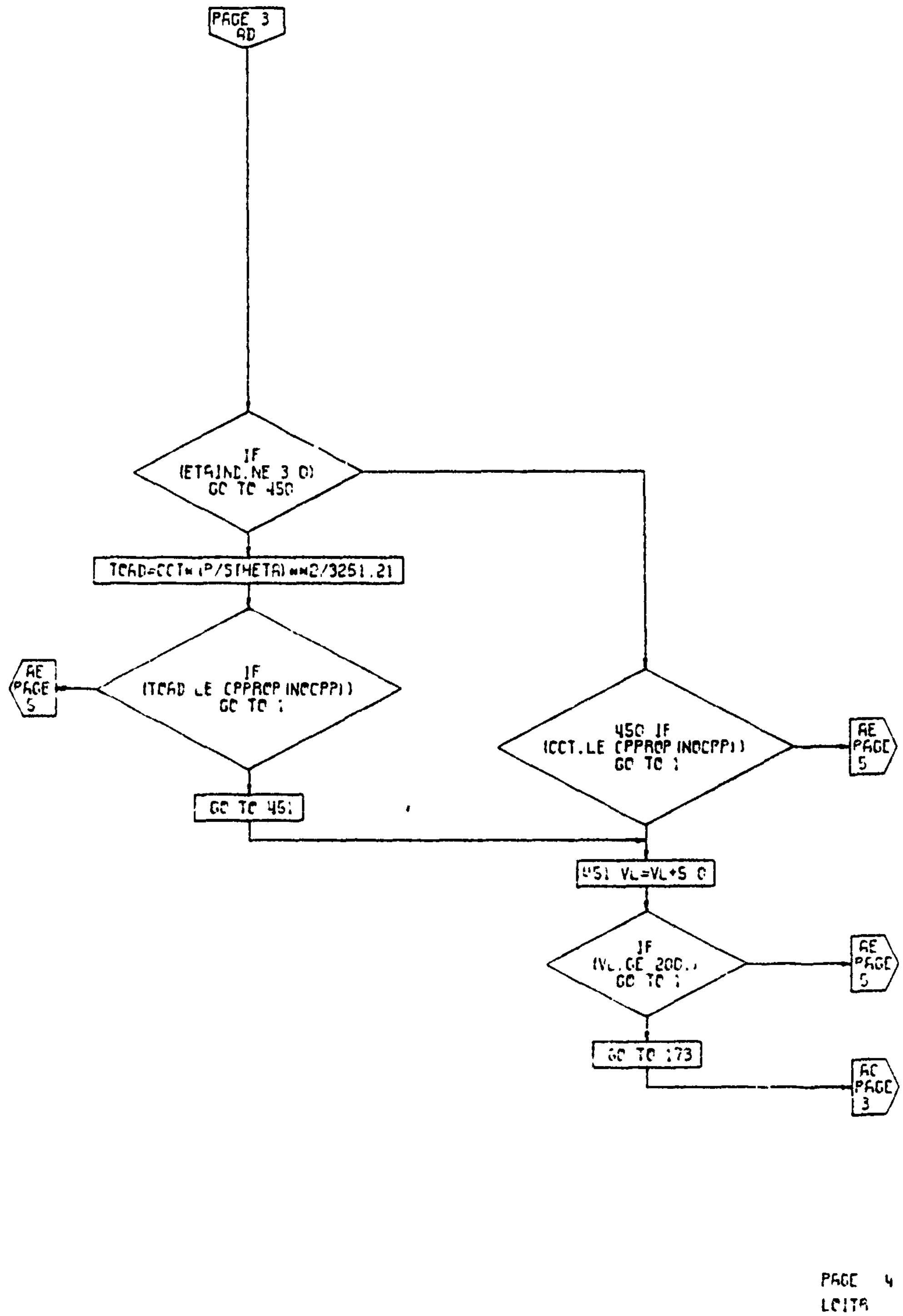


Figure 4-53. LOITER Calculations Subroutine,
Flow Chart (Part 3 of 11)

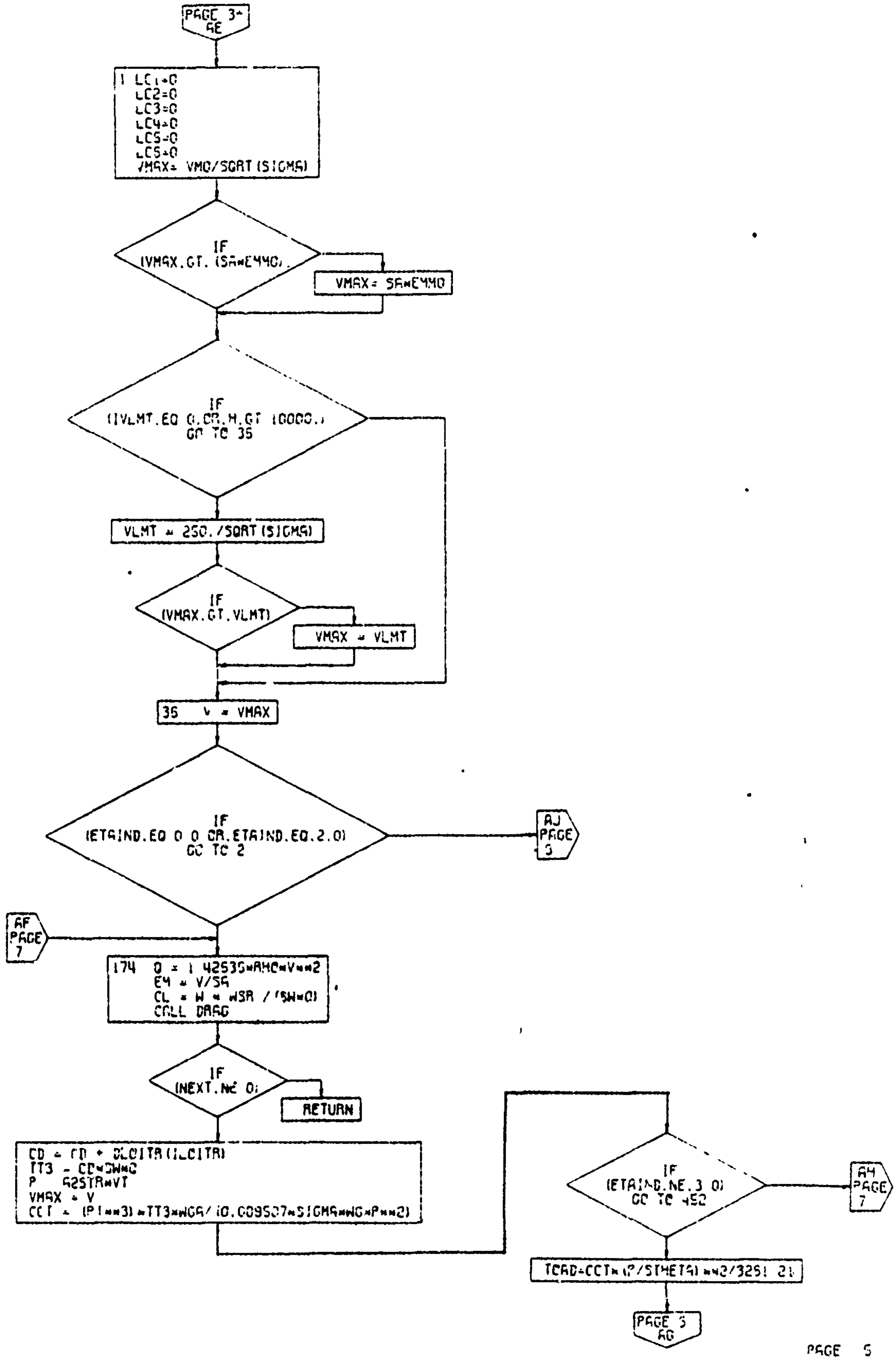
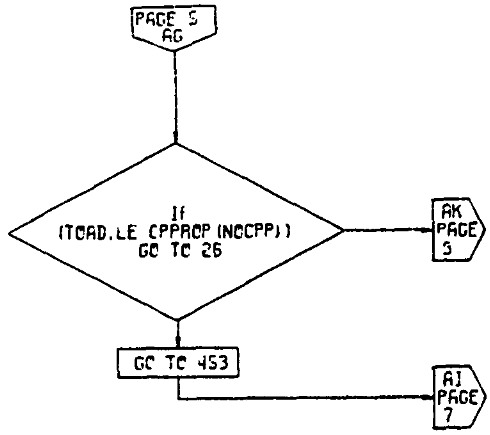
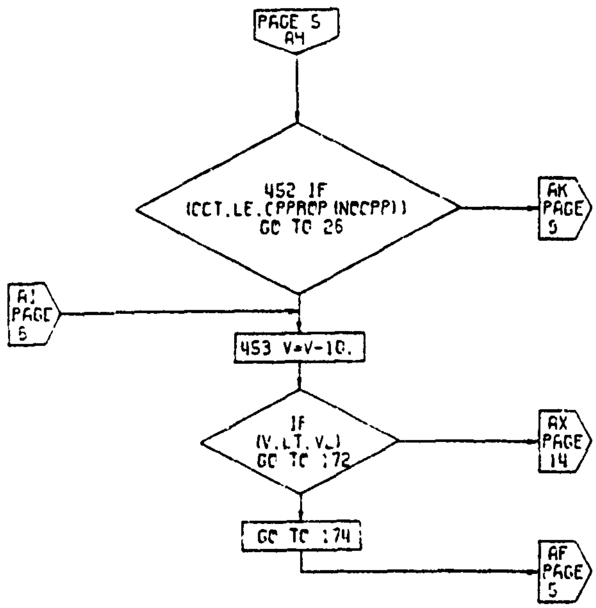


Figure 4-53. LOITER Calculations Subroutine, Flow Chart (Part 4 of 11)



PAGE 6
LOITR



PAGE 7
LOITR

Figure 4-53. LOITER Calculations Subroutine, Flow Chart (Part 5 of 11)

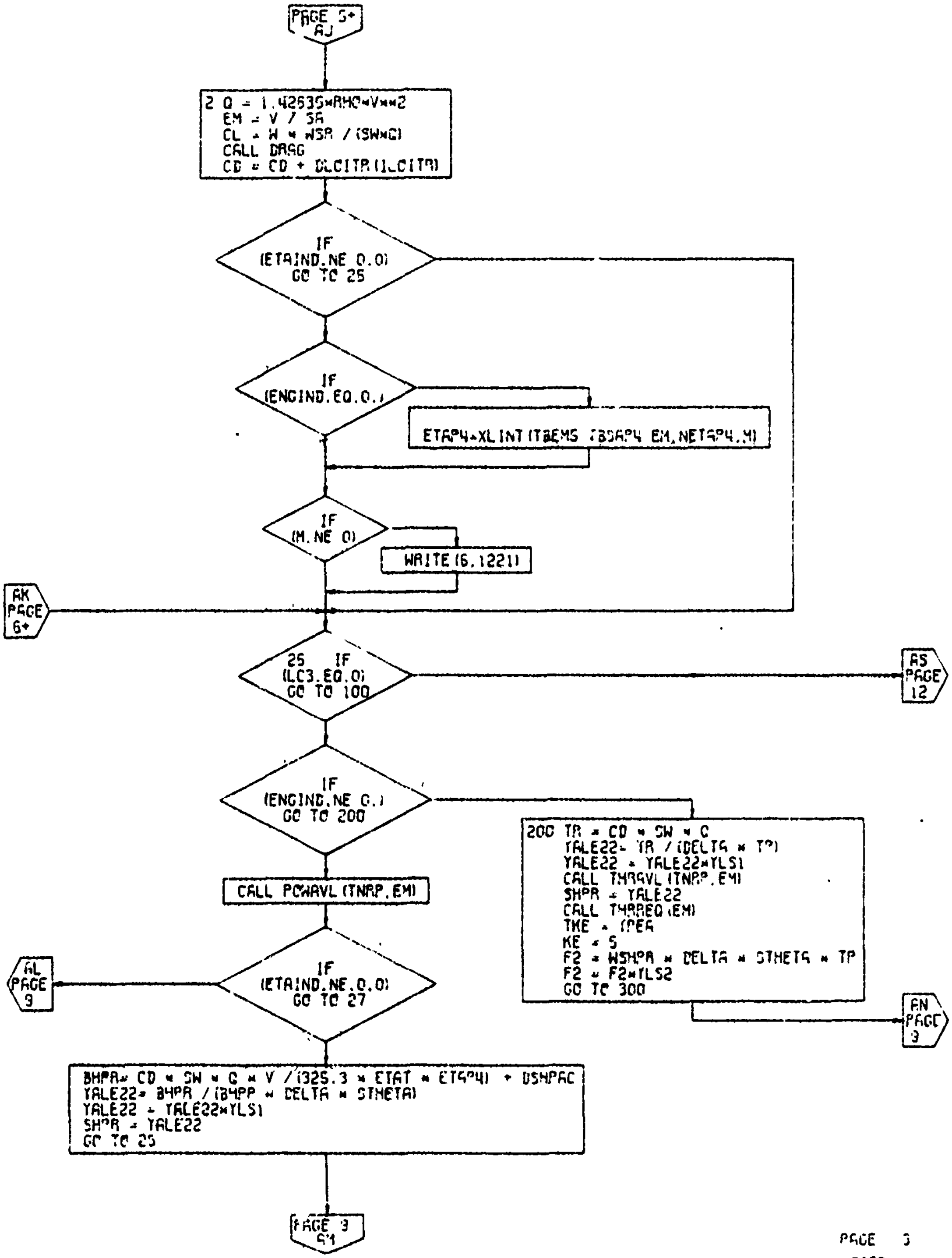


Figure 4-53. LOITER Calculations Subroutine, Flow Chart (Part 6 of 11)

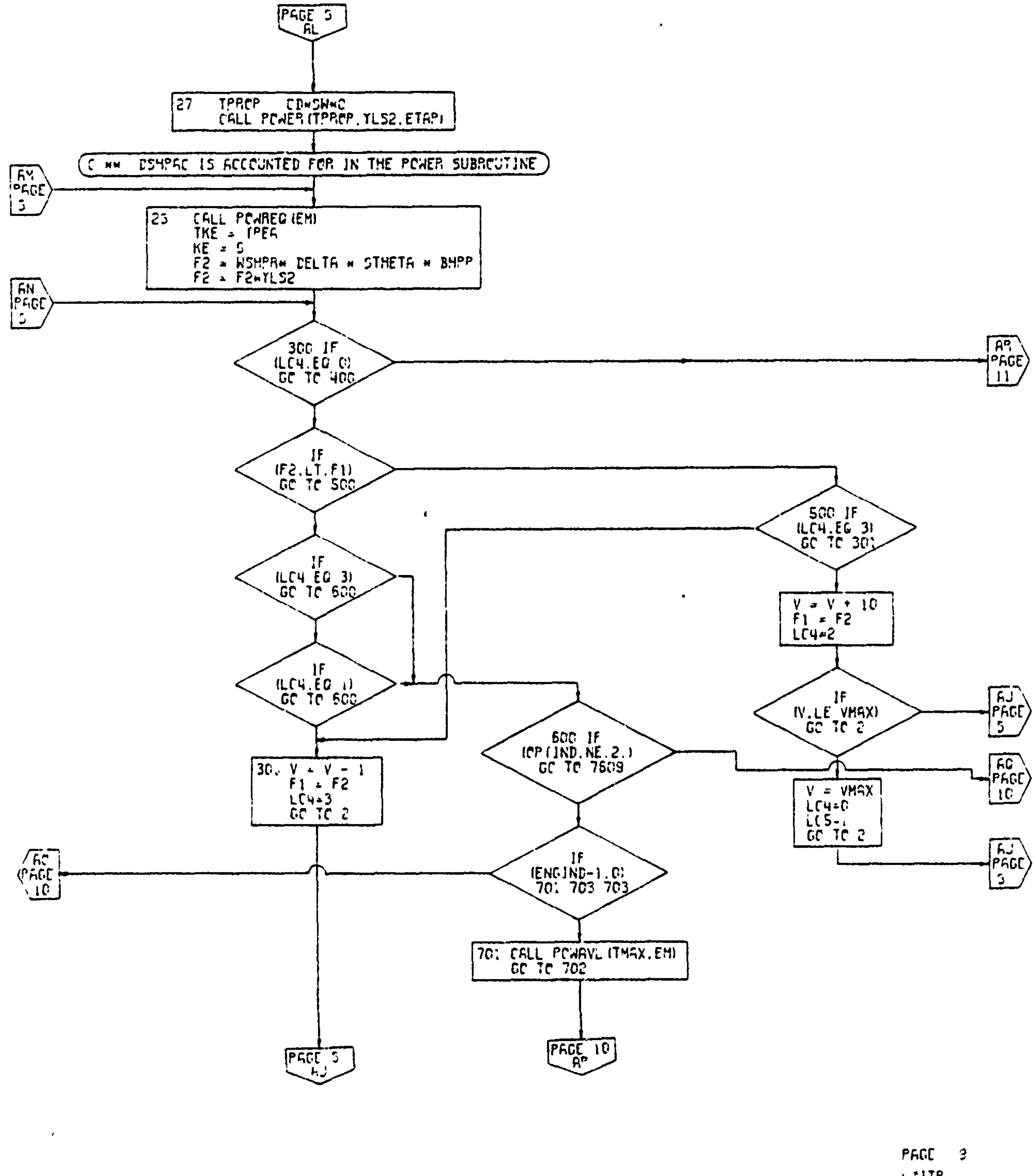


Figure 4-53. LOITER Calculations Subroutine, Flow Chart (Part 7 of 11)

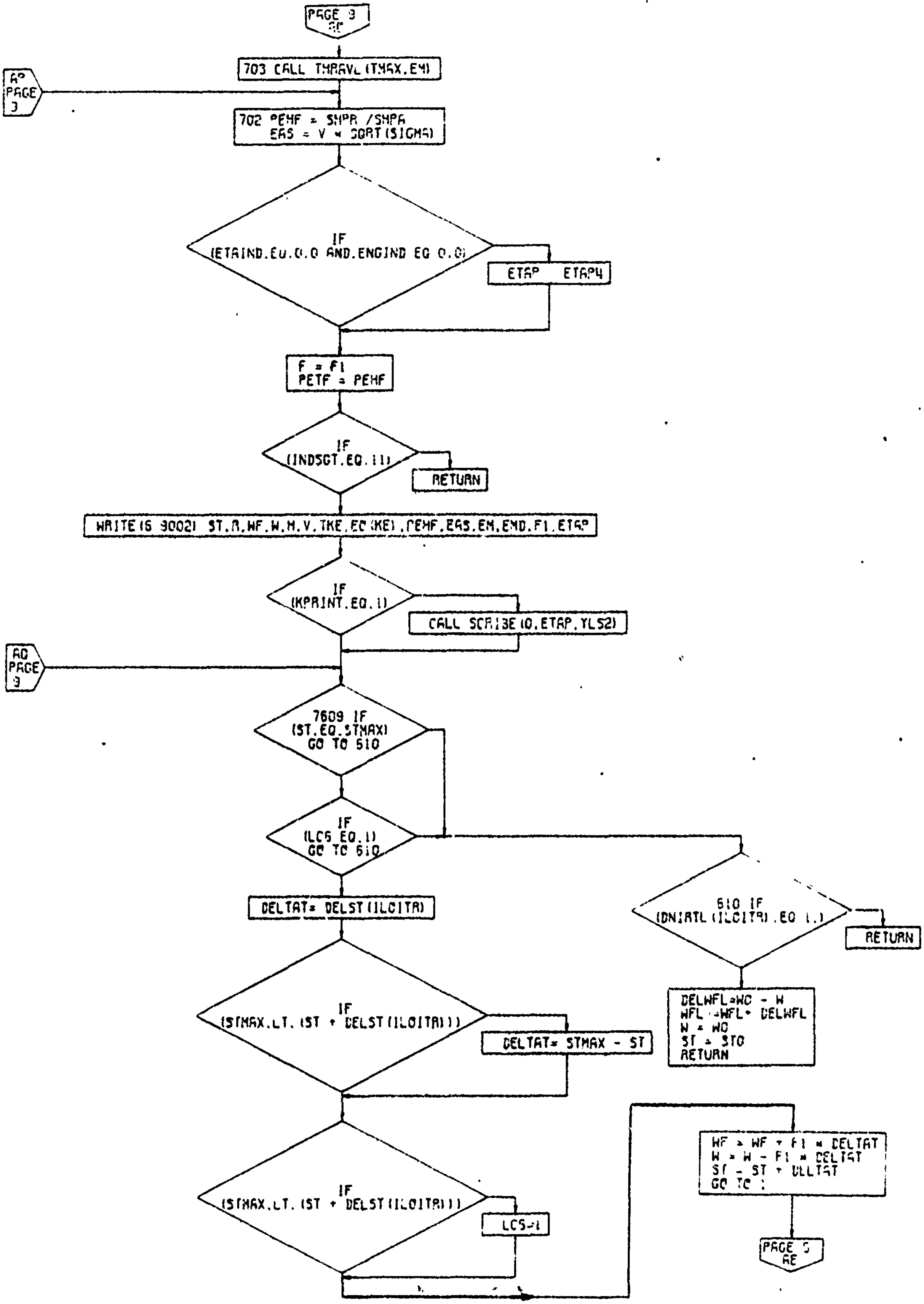
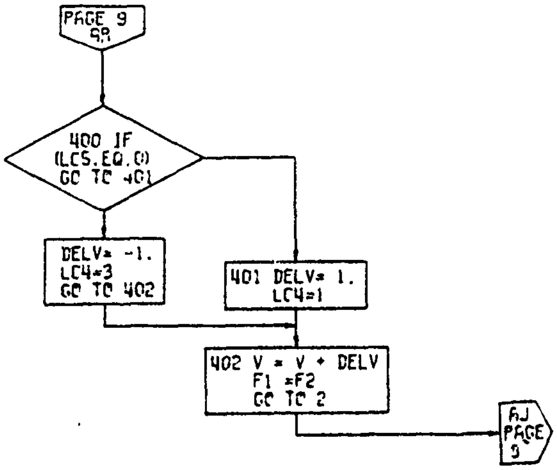
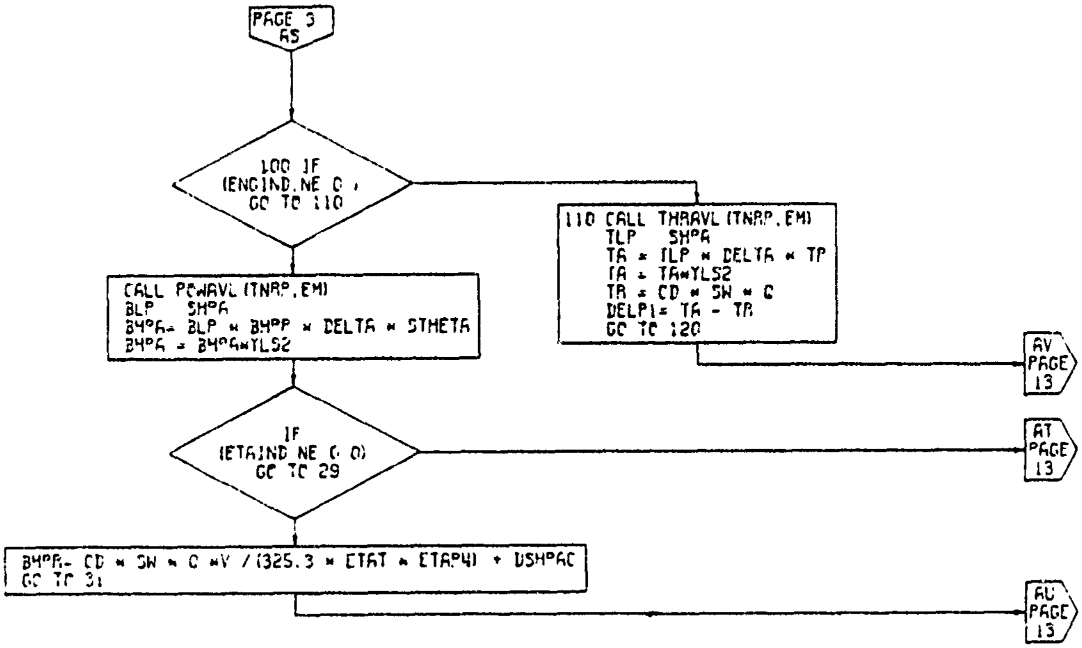


Figure 4-53. LOITER Calculations Subroutine, Flow Chart (Part 8 of 11)



PAGE 11
LOITR



PAGE 12
LOITR

Figure 4-53. LOITER Calculations Subroutine, Flow Chart (Part 9 of 11)

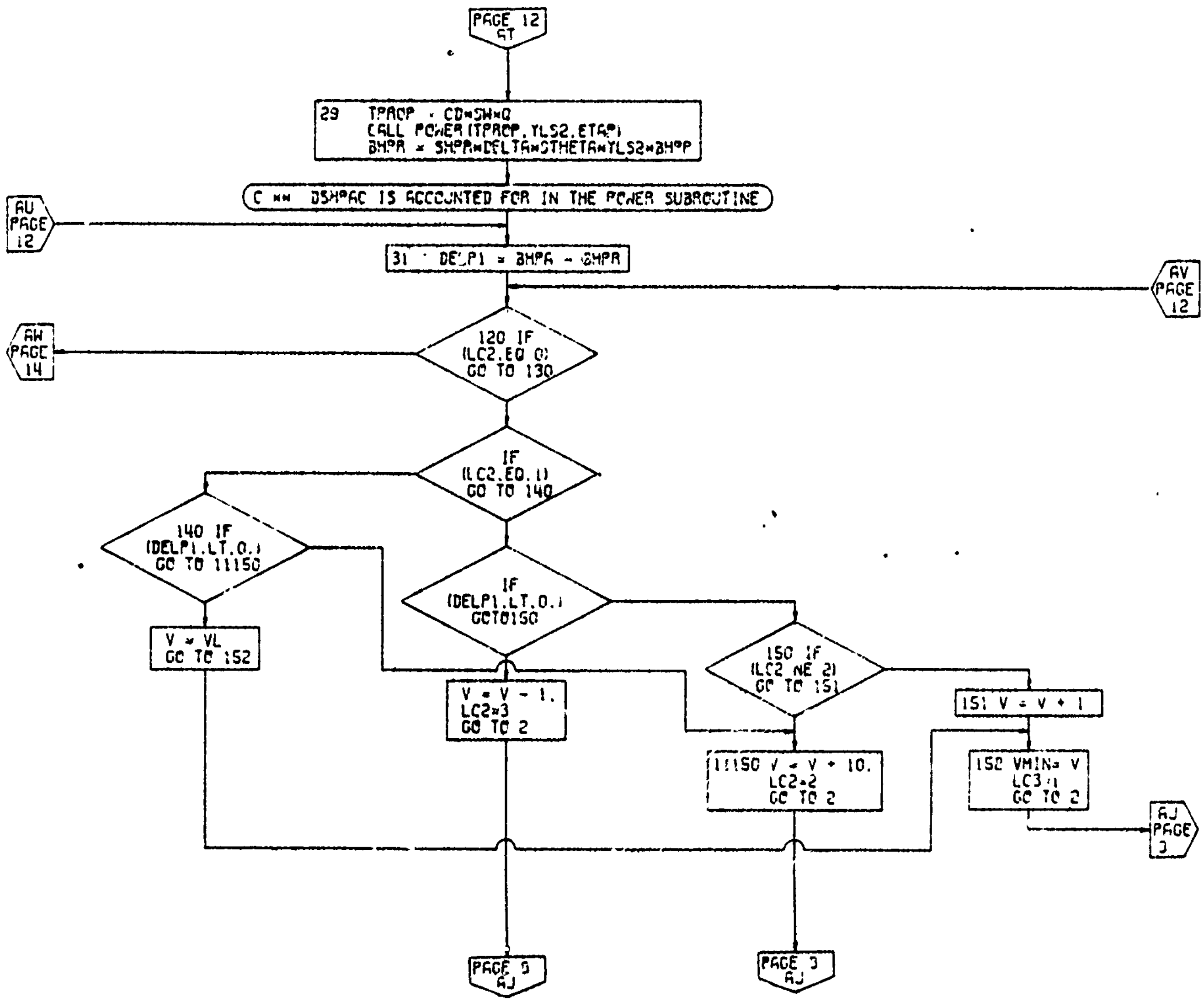


Figure 4-53. LOITER Calculations Subroutine, Flow Chart (Part 10 of 11)

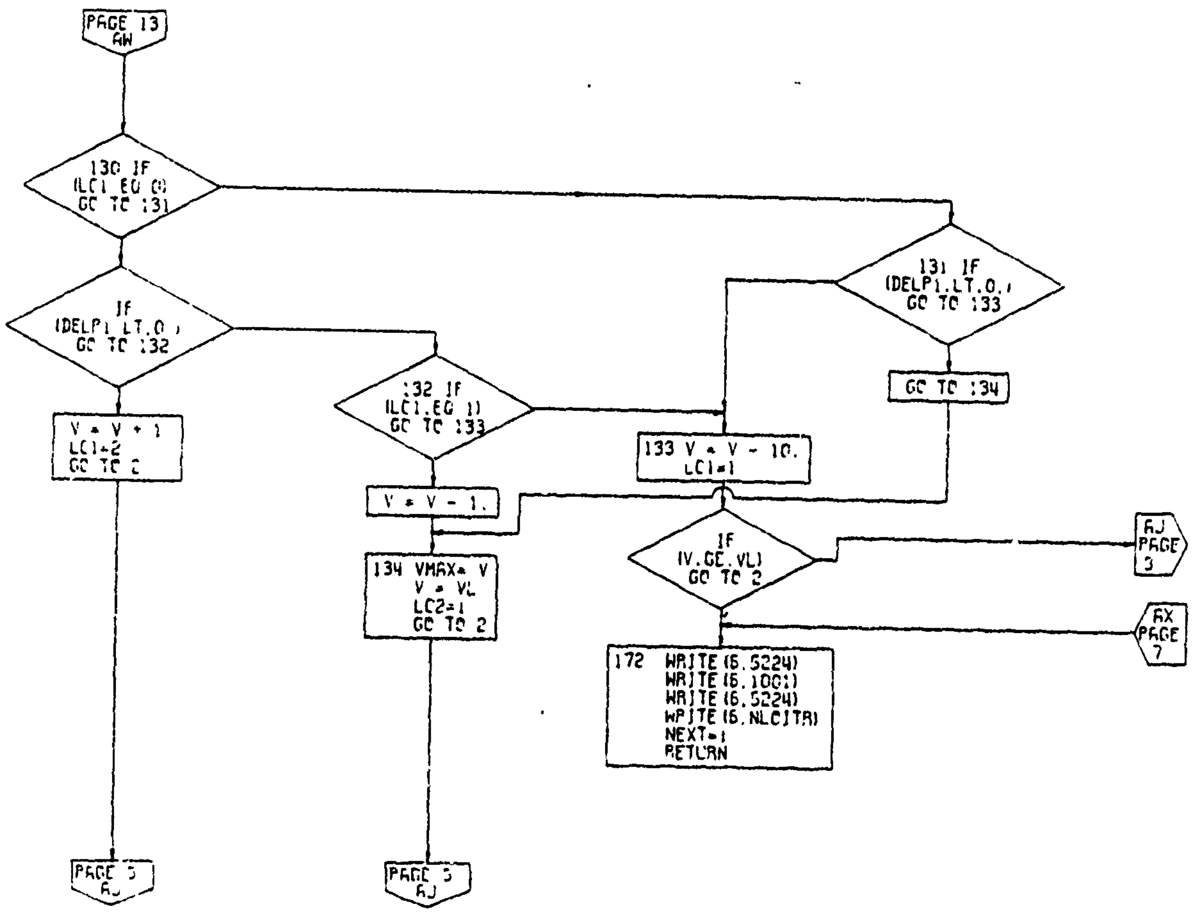


Figure 4-53. LOITER Calculations Subroutine, Flow Chart (Part 11 of 11)

4.10.7 Change of Weight Subroutines

The seventh and eighth performance segments represent an incremental change in weight of fuel or payload. These options would be used to simulate refueling, unloading or loading of passengers, or a fuel drop. The input to the subroutines consists of the increment in weight and a corresponding increment in time. The fuel or payload weight which is added is not allowed to increase the aircraft weight to a value greater than the gross weight unless a performance case is being run and WGTIND = 1. Inputting a large value for the increment in weight will bring the aircraft weight up to gross weight if WGTIND = 0 or a sizing case is being run. Figures 4-54 and 4-55 are flow charts of these subroutines.

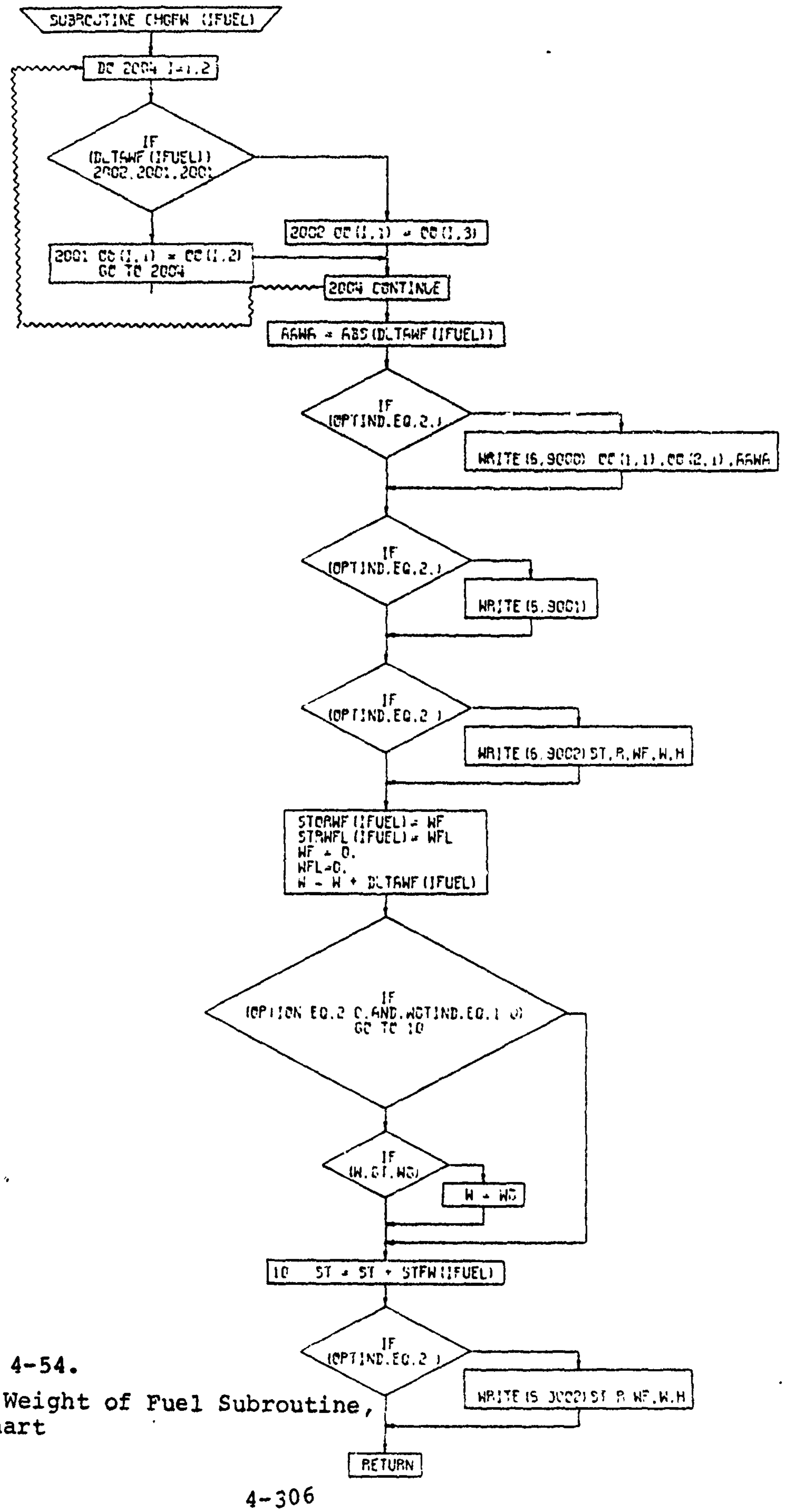


Figure 4-54.

Change Weight of Fuel Subroutine, Flow Chart

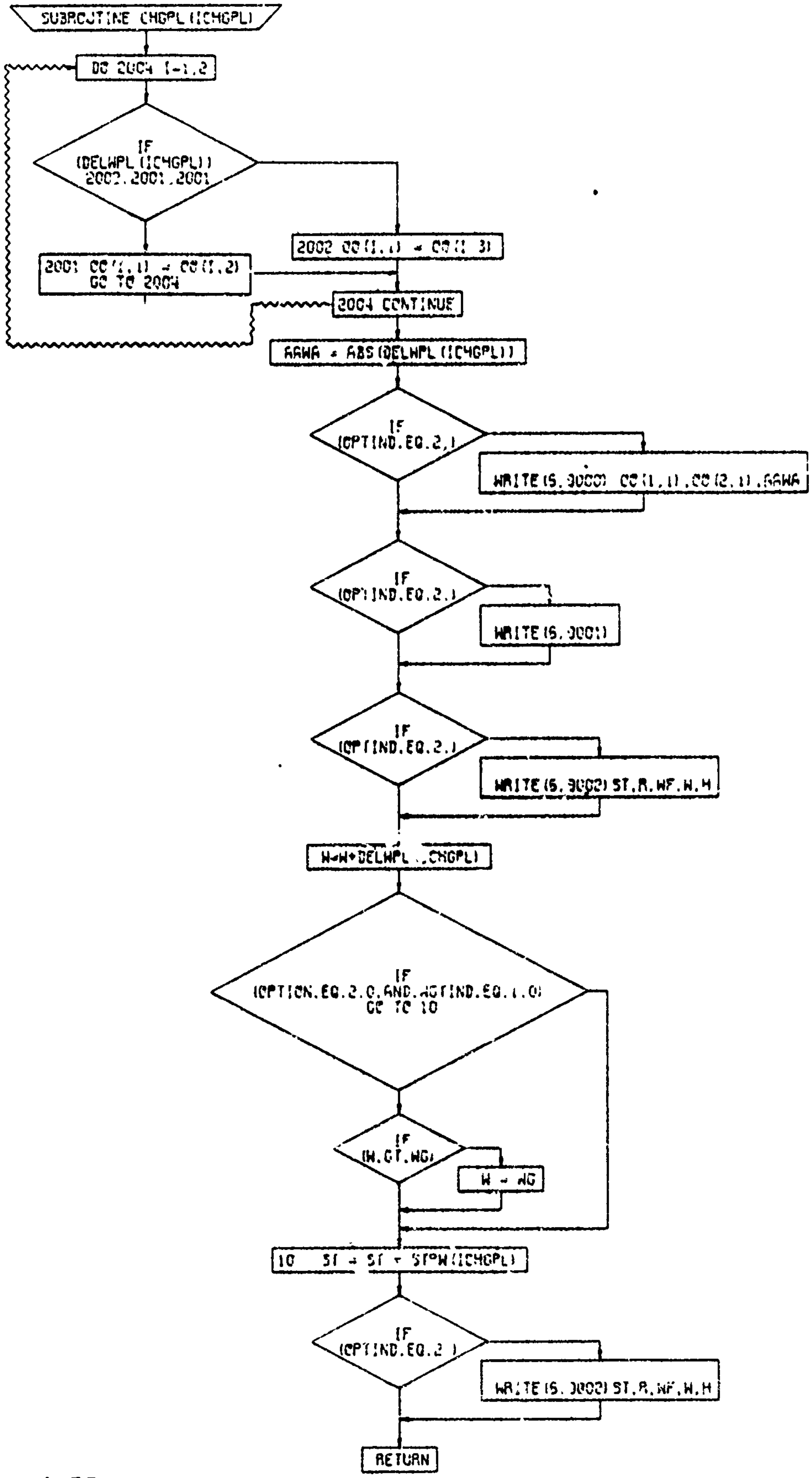


Figure 4-55. Change of Payload Weight Subroutine, Flow Chart

4.10.8 Transfer Altitude

There are many different applications for which a discontinuous change in altitude may be desirable:

a. The flight profile may require takeoff at hot day, high altitude conditions followed by climb from sea level to specified altitude for standard day conditions.

b. It may be required that no credit be taken for range, fuel, or distance during descent (for example, Reference 5).

c. It may be required to study cruise speed at specified power at a series of different altitudes. This can be accomplished by a series of very short cruise segments interspersed with altitude transfers.

For these and other reasons, the program includes a transfer altitude segment, specified by SGTIND = 9. The only required input is the altitude to which the airplane is to be transferred.

Transfer altitude may also be used during an optimum altitude search when it is followed by a cruise. In that case, the altitude which is input represents the maximum altitude permitted for the subsequent cruise.

Figure 4-56 is a flow chart of this subroutine.

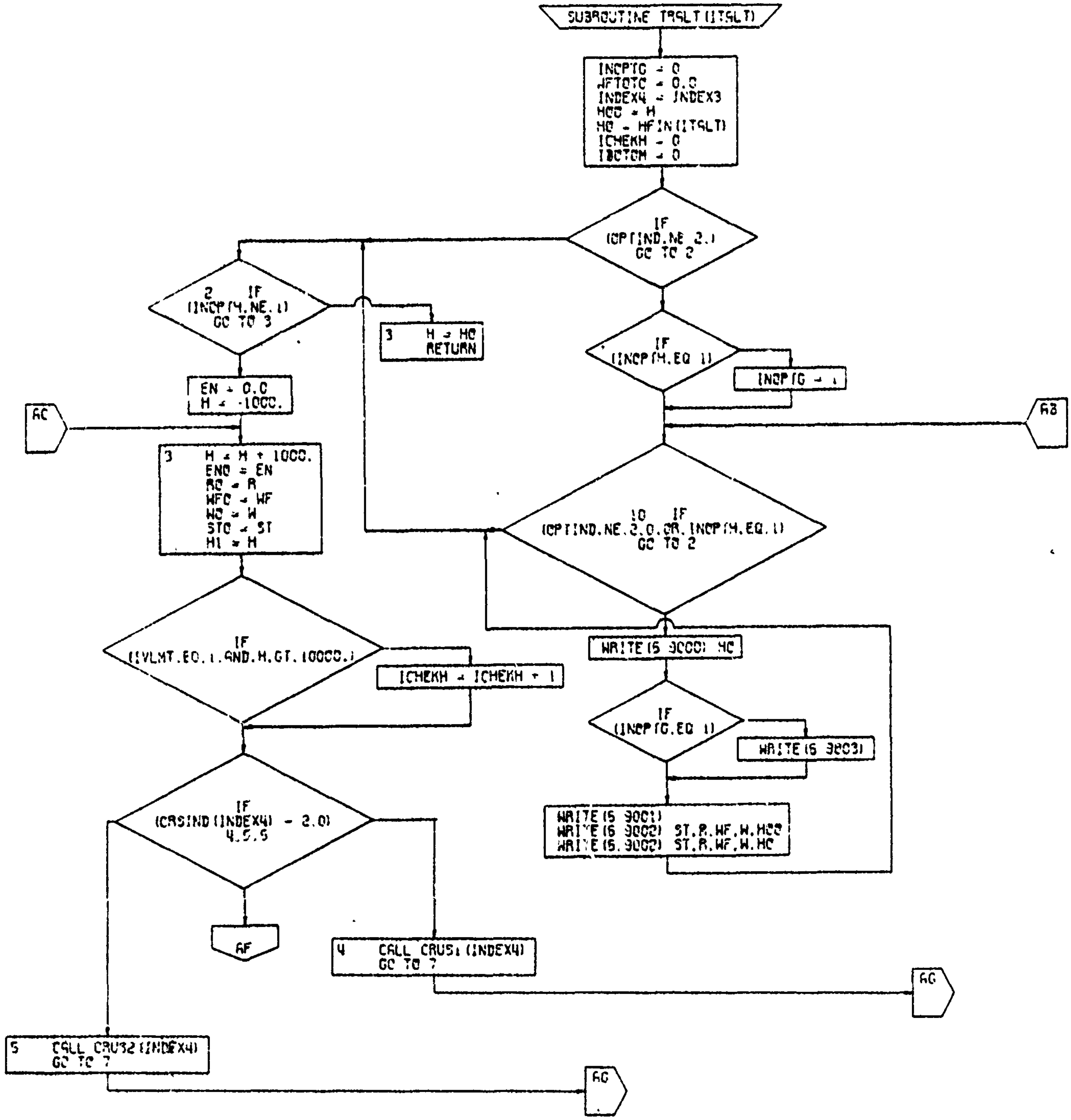


Figure 4-56. Transfer Altitude Subroutine, Flow Chart (Part 1 of 3)

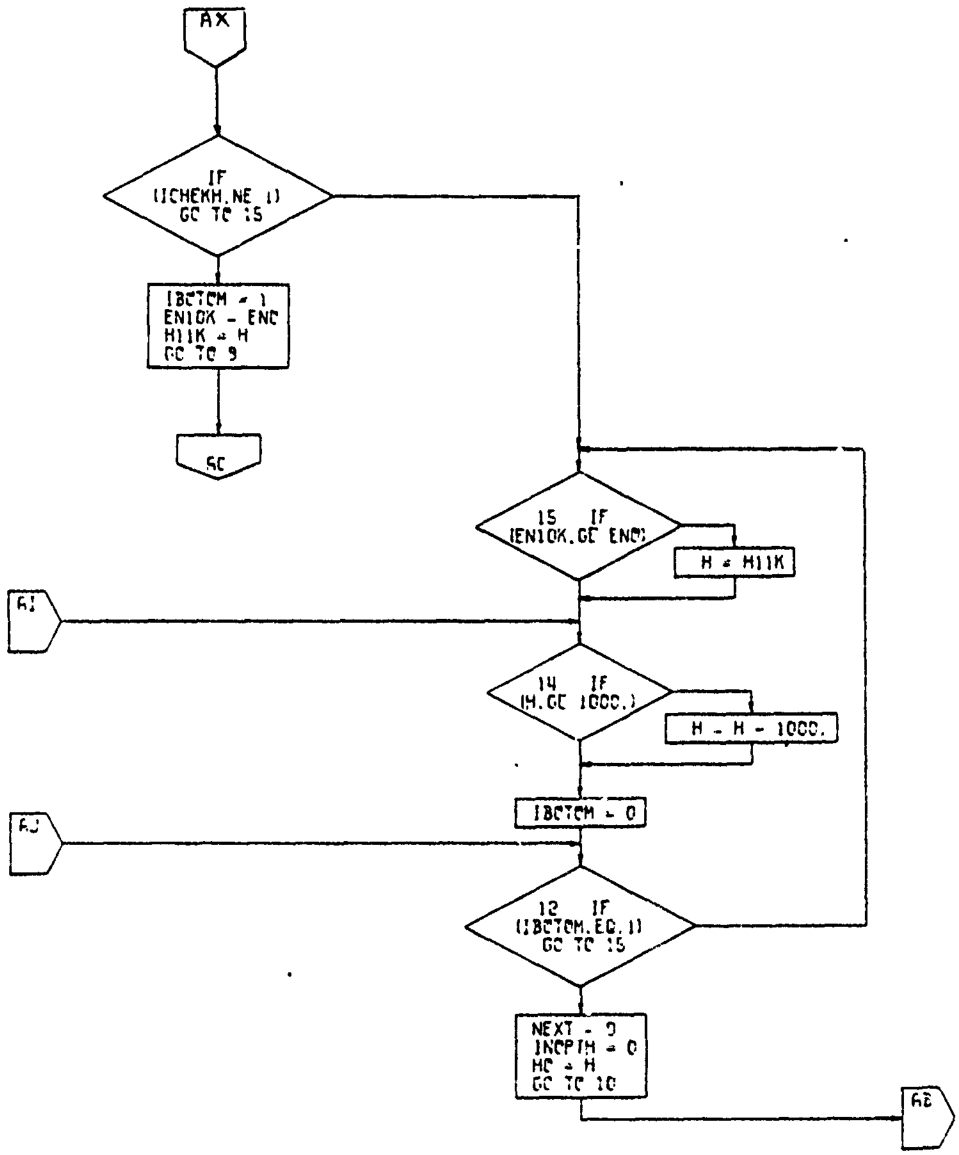


Figure 4-56. Transfer Altitude Subroutine, Flow Chart (Part 2 of 3)

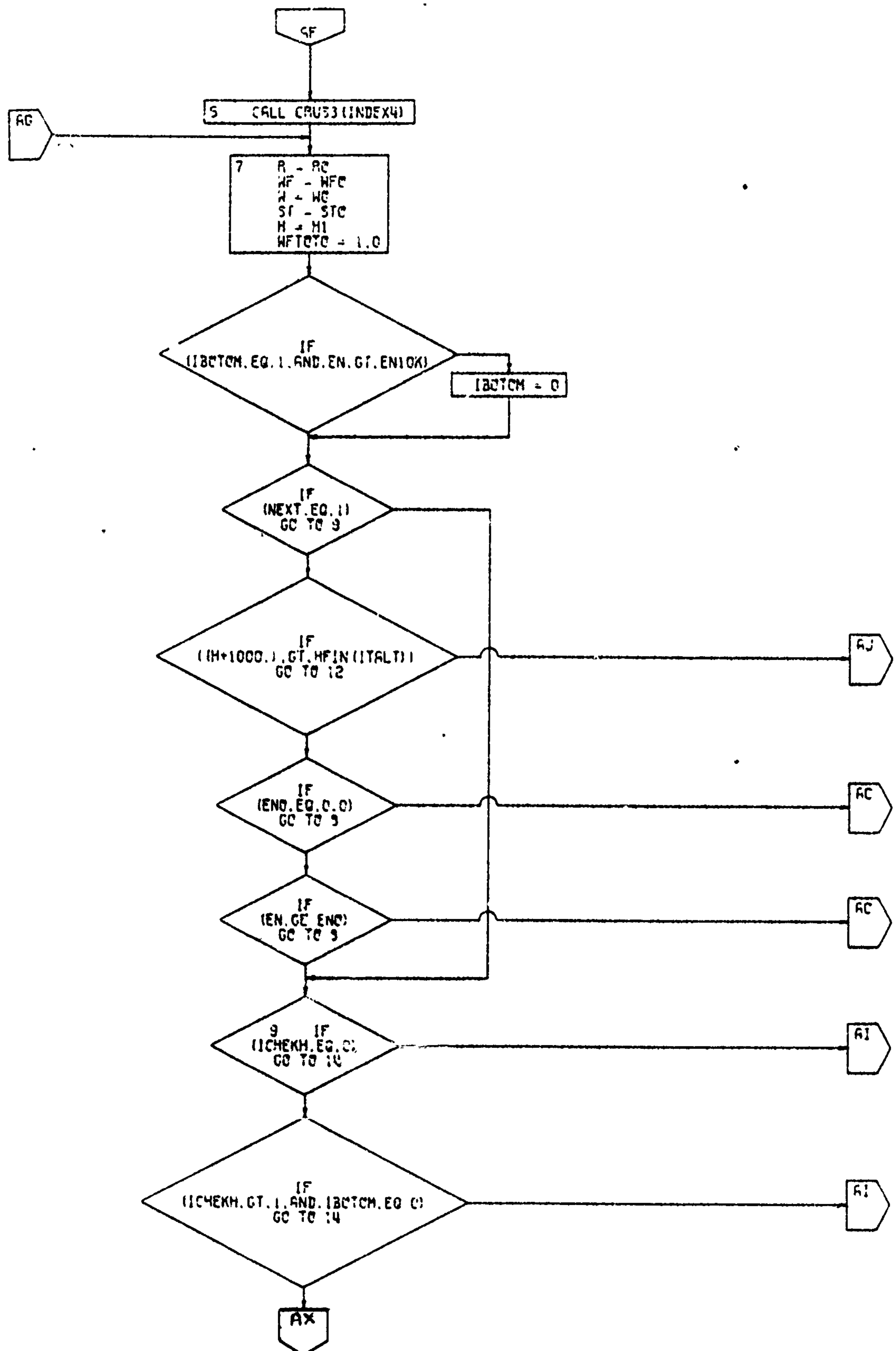


Figure 4-56. Transfer Altitude Subroutine, Flow Chart (Part 3 of 3)

4.10.9 General Performance

SGTIND = 11 represents the calculation of aircraft general performance. The general performance calculation is based on gross weight or a change in gross weight as determined by the input indicator GWIND. If

GWIND = 1. - User inputs the incremental change in gross weight into LOC(2211)

GWIND = 2. - User inputs gross weight into LOC(2211).

The Fortran code of the general performance subroutine has been assembled primarily from existing VASCOMP II coding. The program section for hover utilizes the coding from subroutine TOHL, with a built-in TOLIND value (LOC(0601)) equal to 1.0. In general performance the user inputs required thrust to weight, LOC(2271). The airplane will use maximum power from lift engines before augmenting with primary engines, or will use only primary engines if no lift engines are specified, LOC(0013) = 0.

The cruise section of general performance is similar to the CRUS2 subroutine with CRSIND, LOC(0801) = 2. In general performance each iterative calculation is done at the present constant TAS.

The aircraft performance is calculated and printed out starting with the hover condition, V=0. The second performance set of values corresponds to the velocity, V_H, at the highest lift coefficient, $C_{L_{MAX}}$, input in locations 0317 - 0324. The third performance set is printed out at the velocity V_H rounded up to the next highest tens value. This rounded velocity is referred to as V_R. Aircraft performance is then calculated and printed out in velocity increments specified in LOC(2291). Performance printed out after V_R utilizes the wing lift coefficient C_L input LOC(2231). In addition to the above inputs, the program user specified the altitude, temperature, power turbine speed ratio, thrust to weight, and incremental change in drag coefficient.

The general performance mission is usually input after an end of mission segment indicator, SGTIND = 0. A flow chart of the subroutine is shown in Figure 4-57.

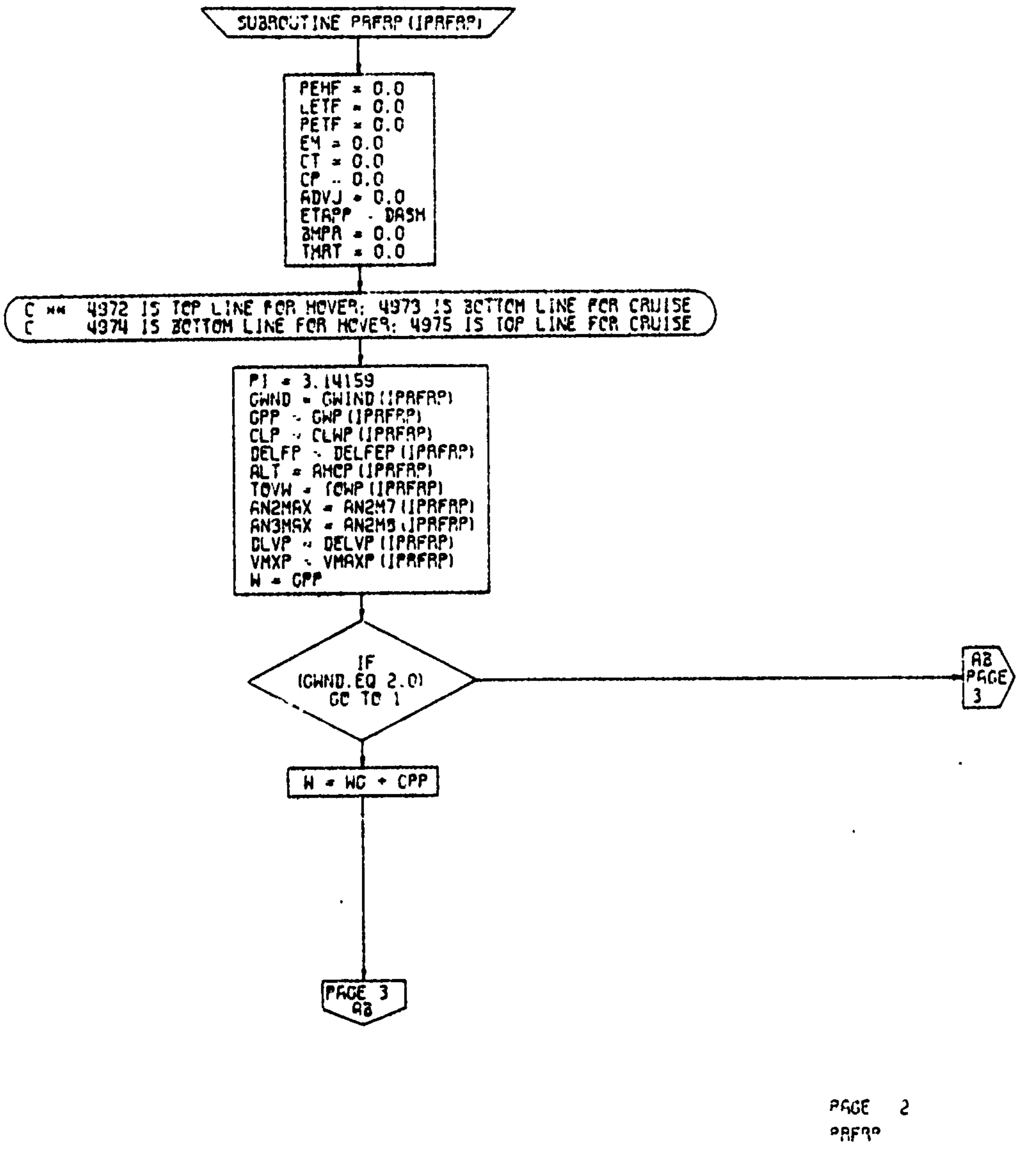


Figure 4-57. General Performance Subroutine, Flow Chart (Part 1 of 13)

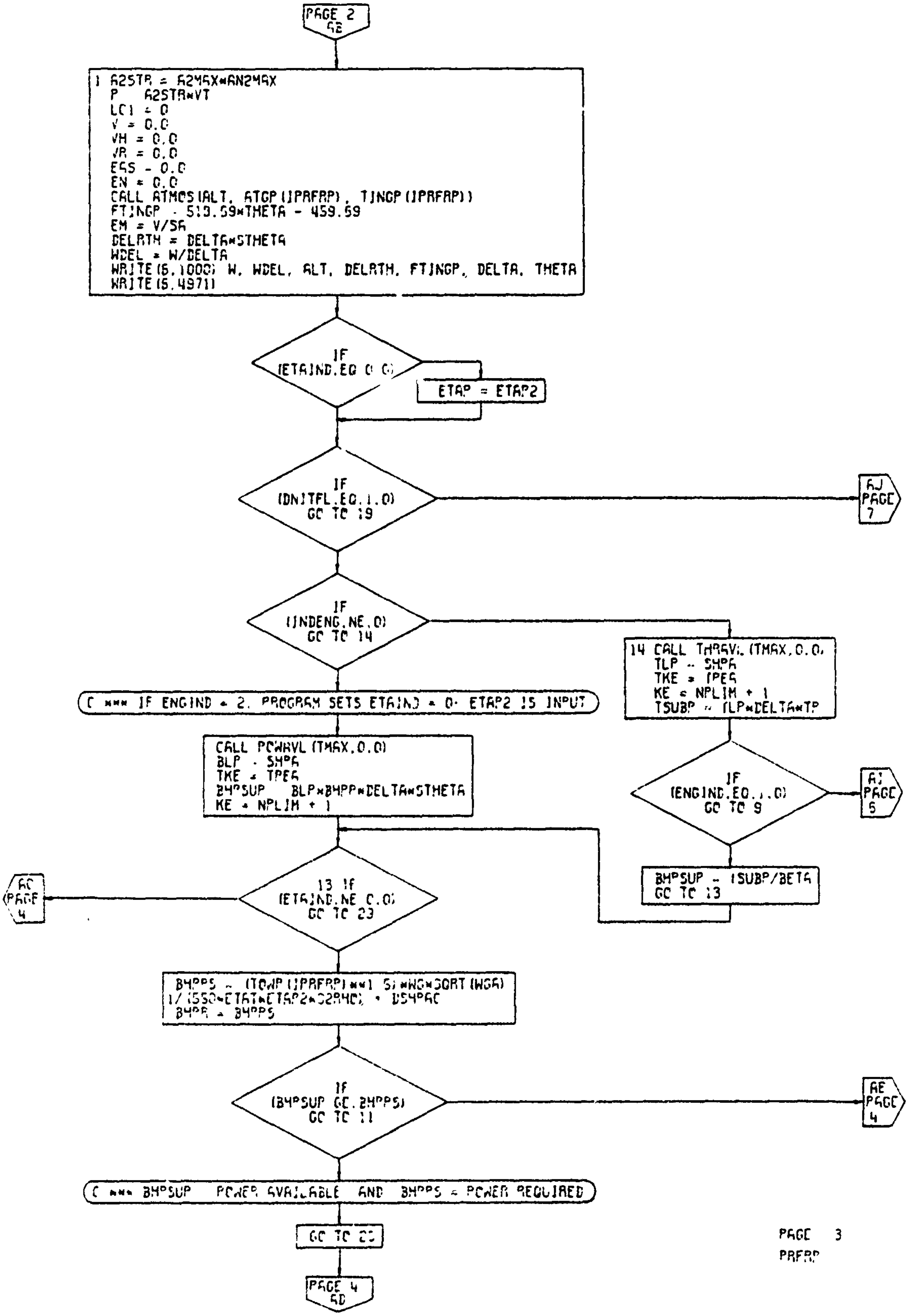


Figure 4-57. General Performance Subroutine, Flow Chart (Part 2 of 13)

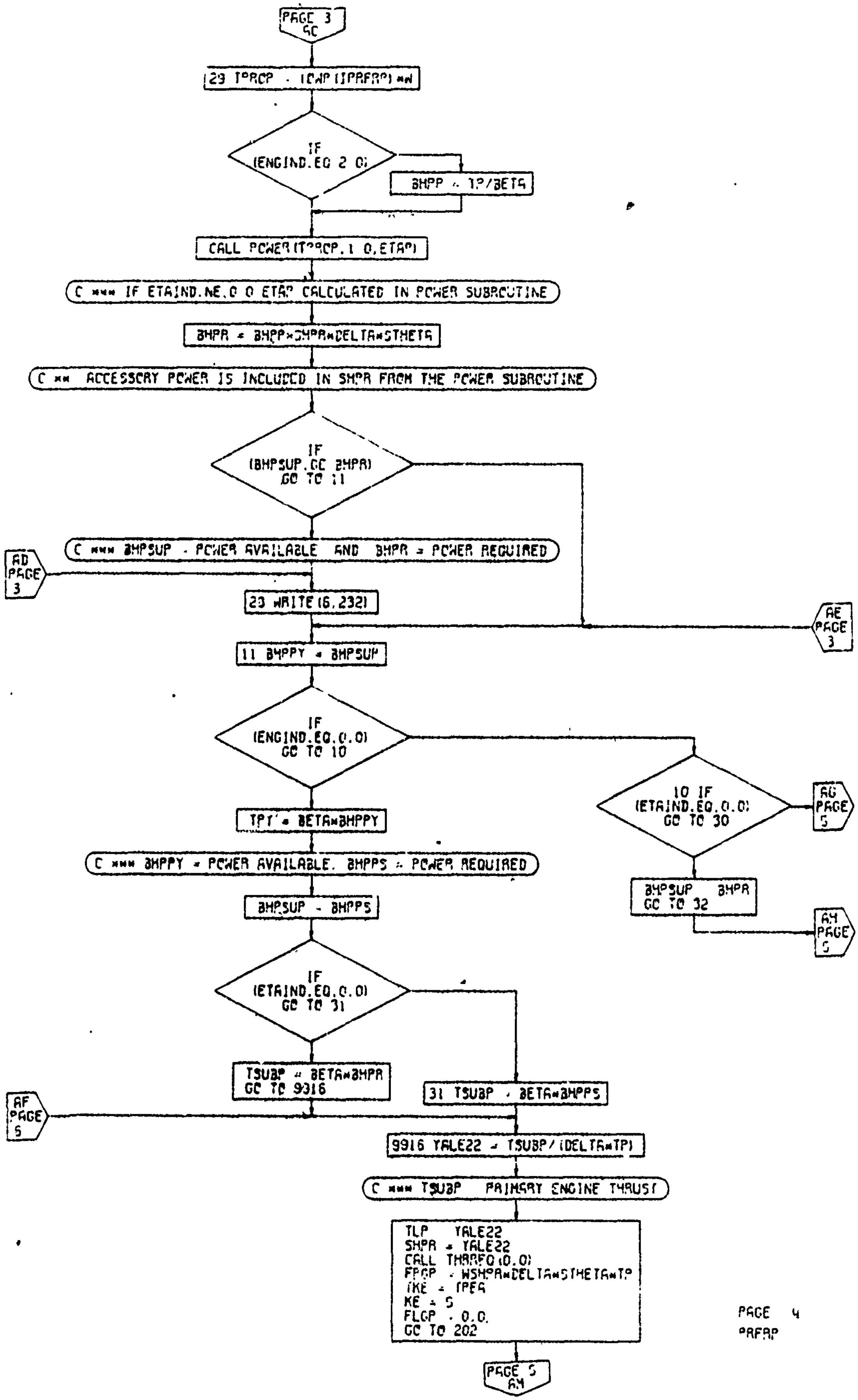


Figure 4-57. General Performance Subroutine, Flow Chart (Part 3 of 13)

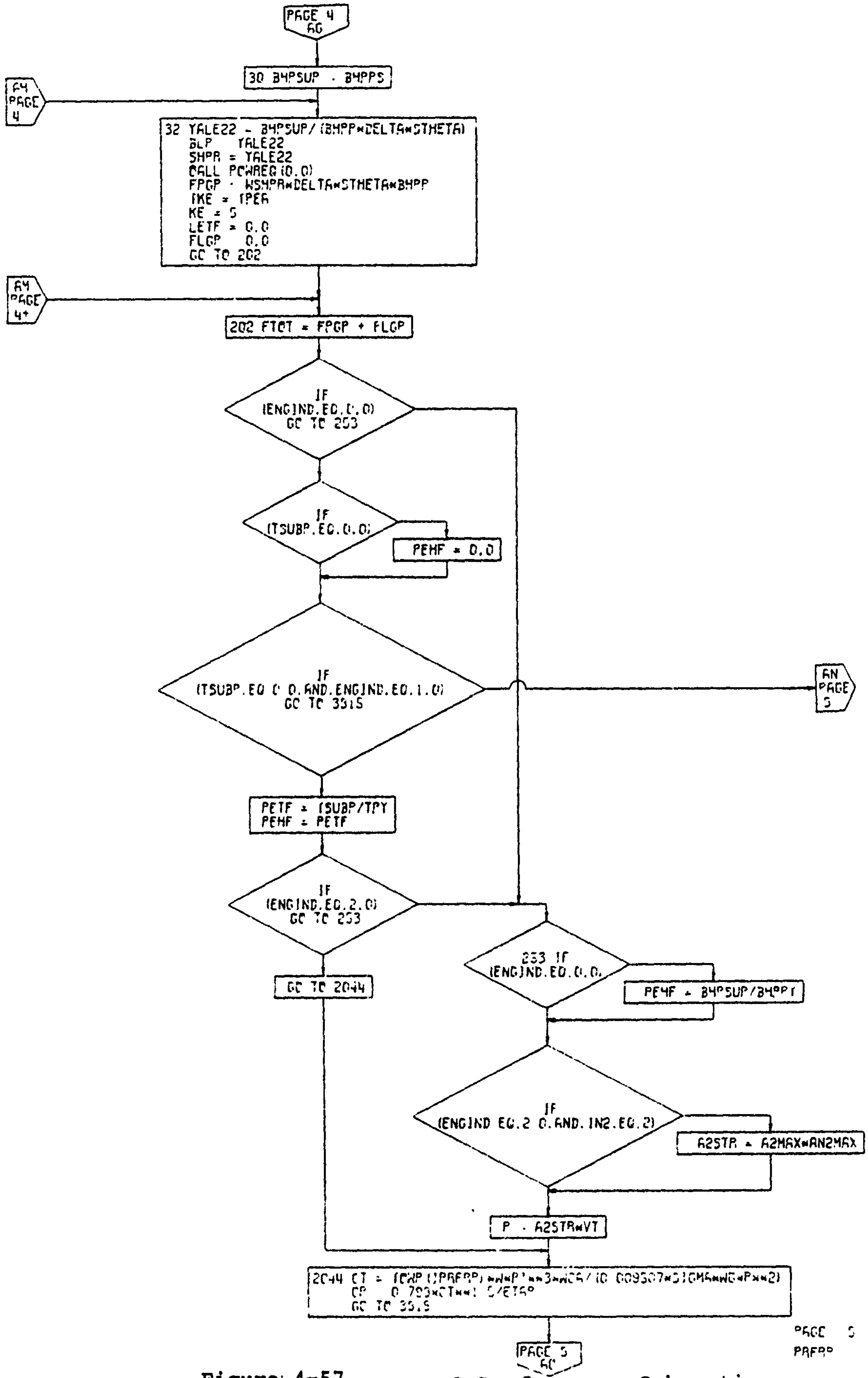


Figure 4-57. General Performance Subroutine, Flow Chart (Part 4 of 13)

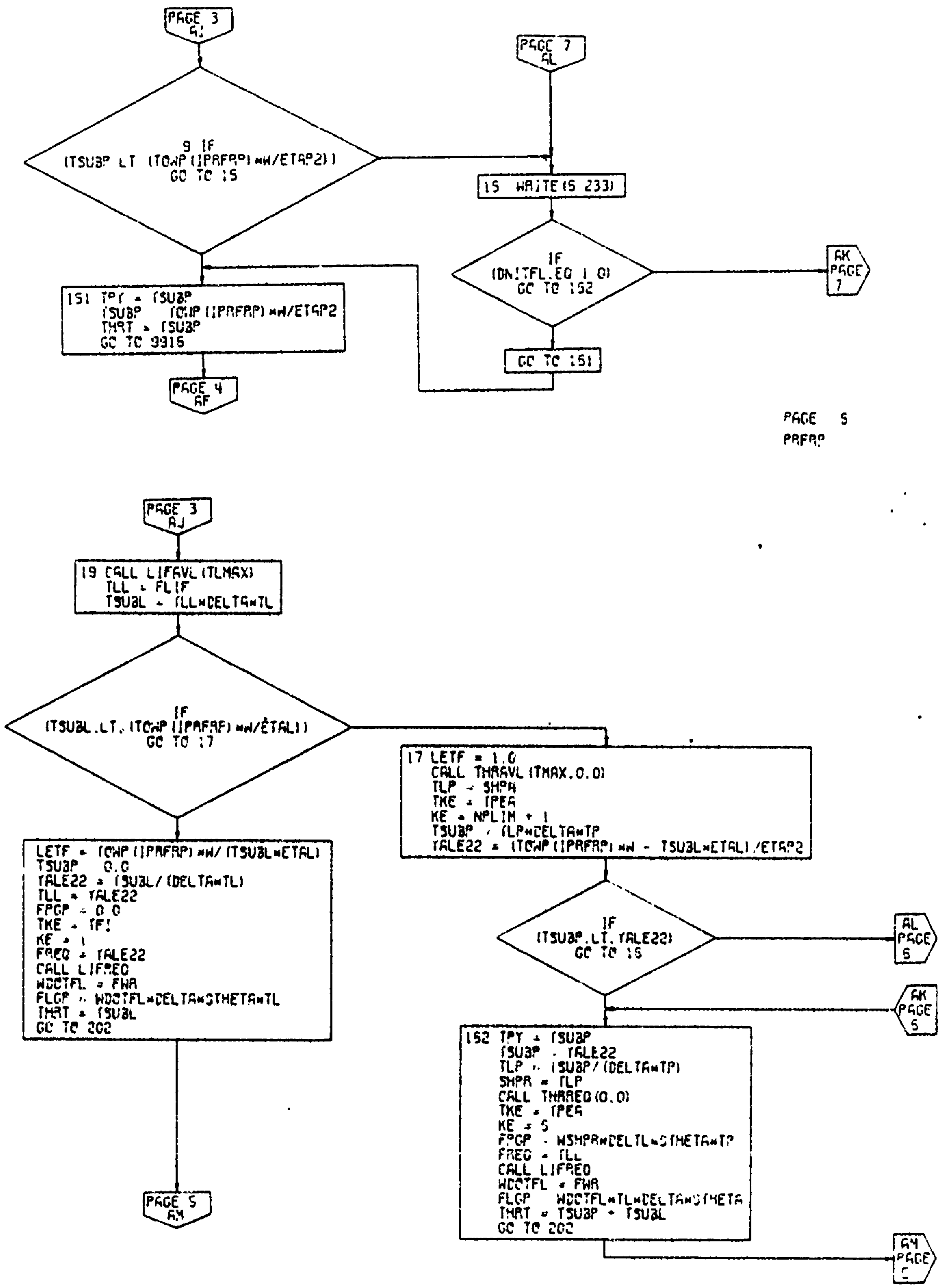


Figure 4-57. General Performance Subroutine, Flow Chart (Part 5 of 13)

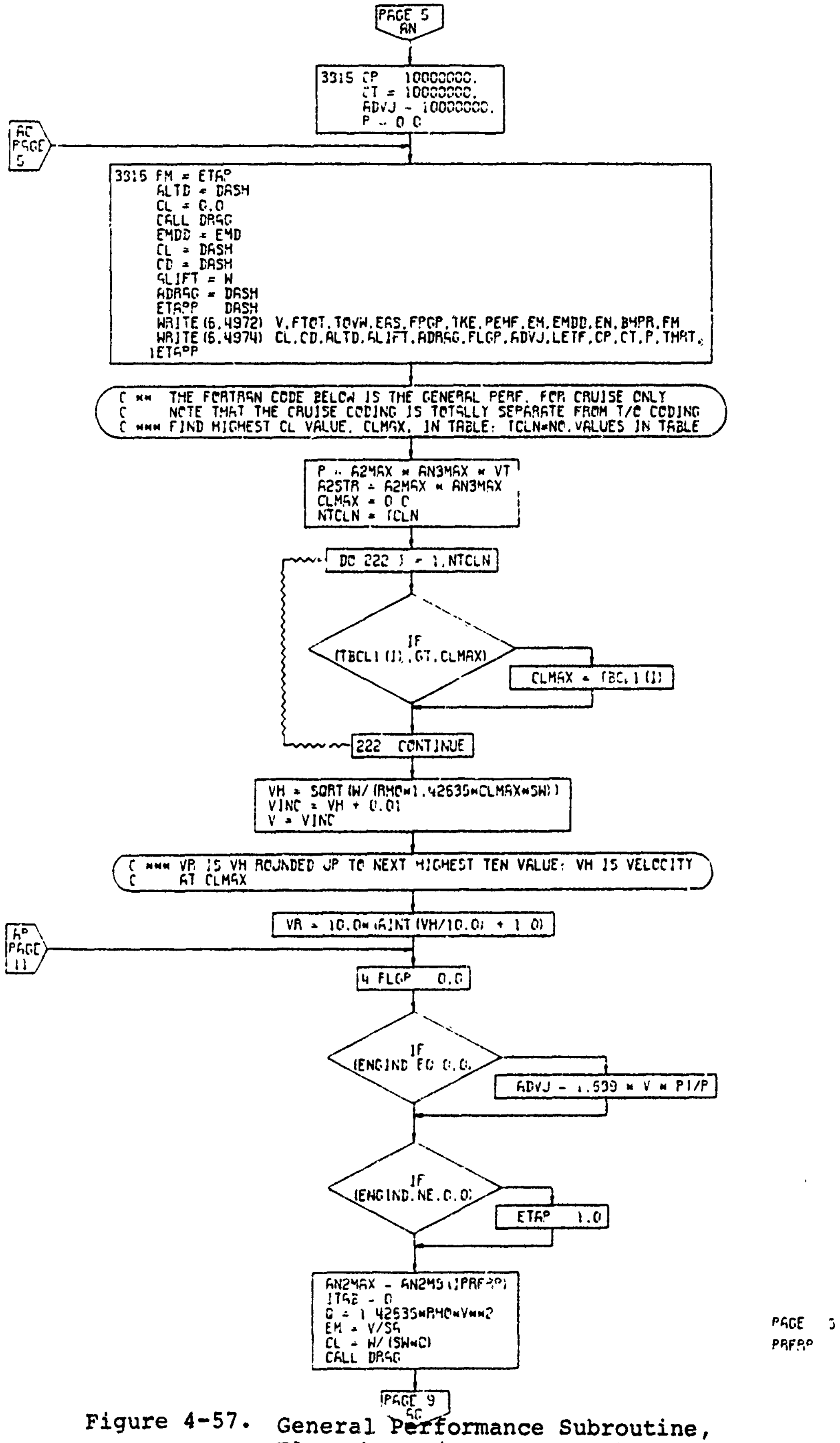


Figure 4-57. General Performance Subroutine, Flow Chart (Part 6 of 13)

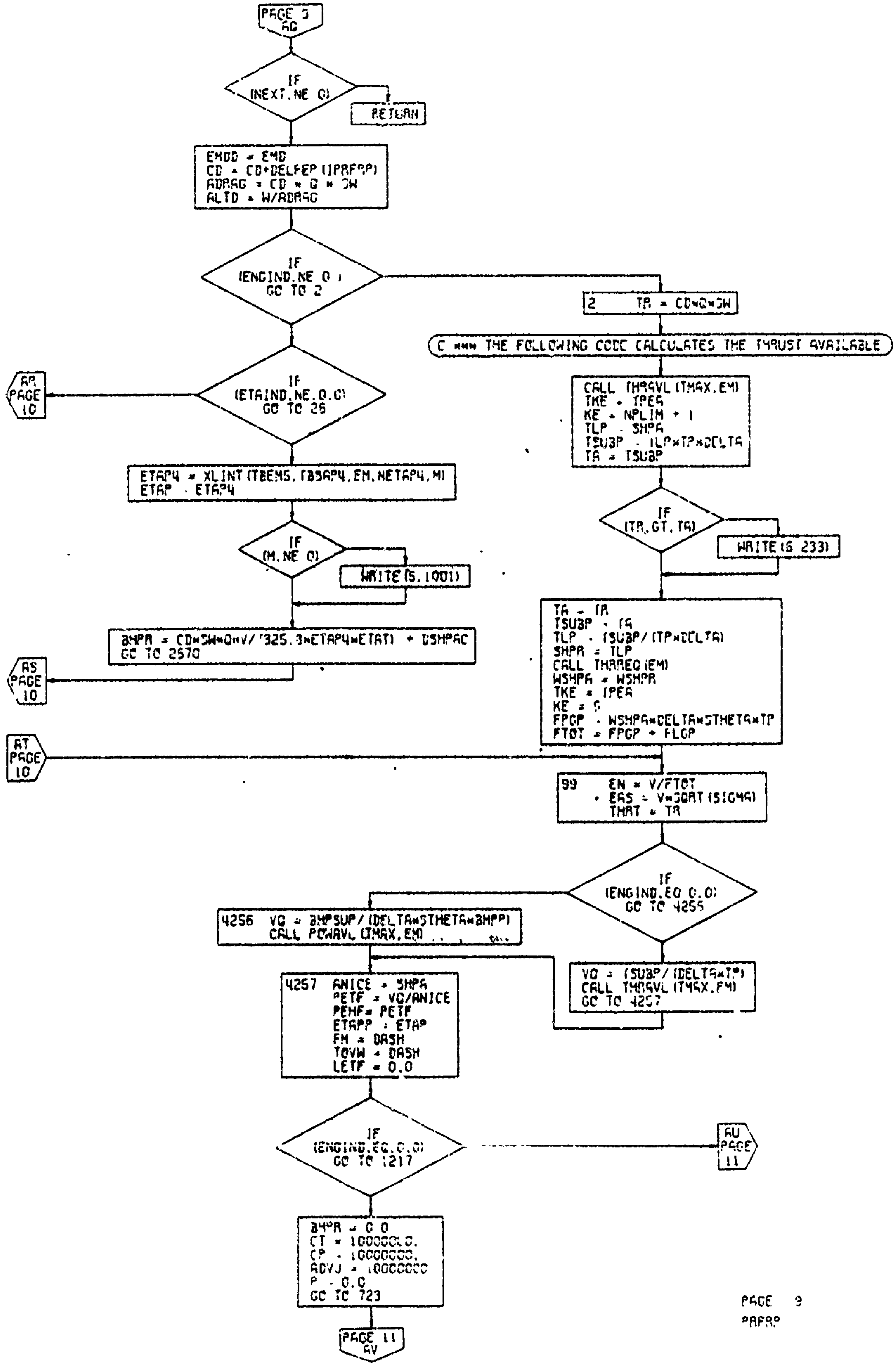


Figure 4-57. General Performance Subroutine, Flow Chart (Part 7 of 13)

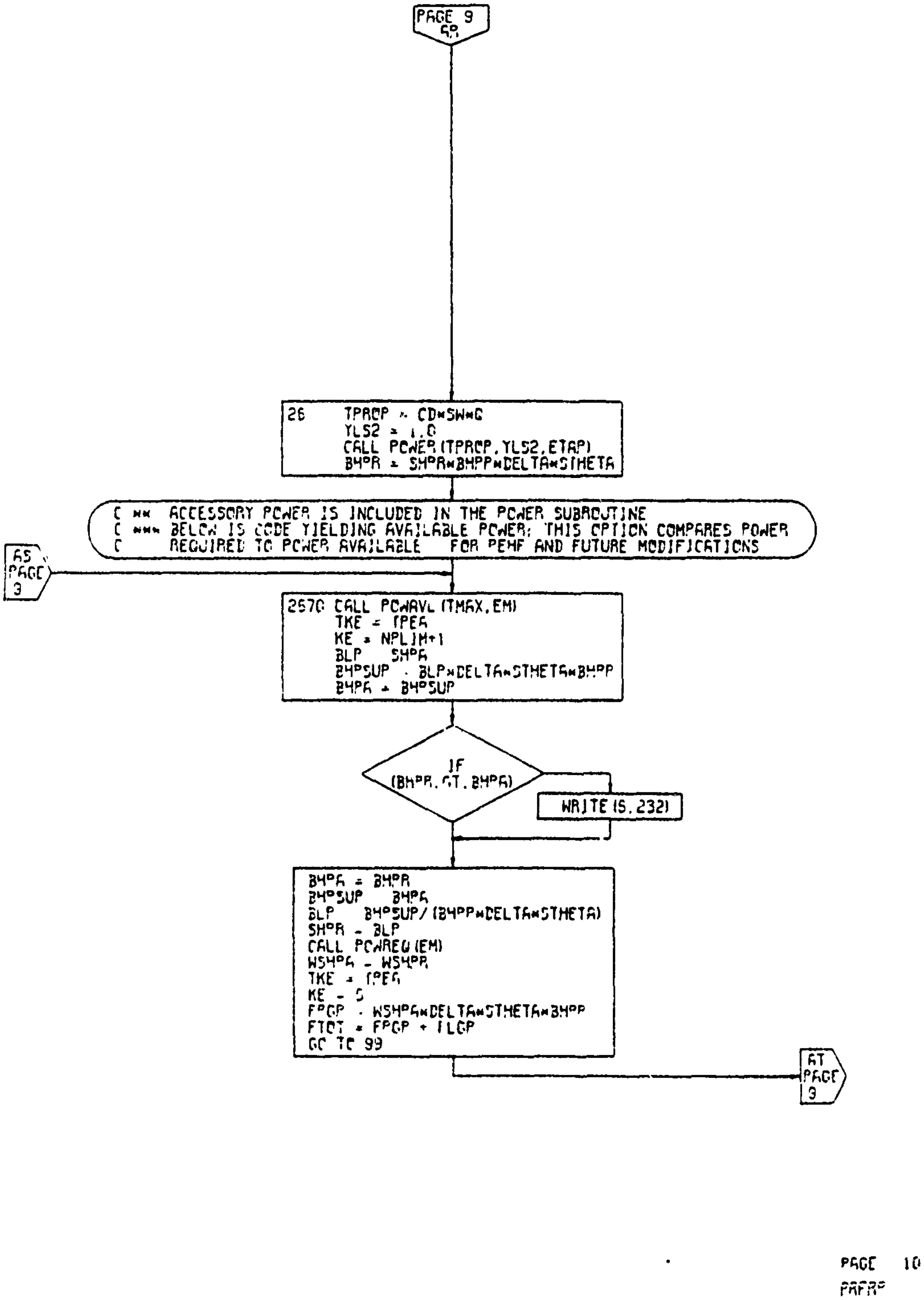


Figure 4-57. General Performance Subroutine, Flow Chart (Part 8 of 13)

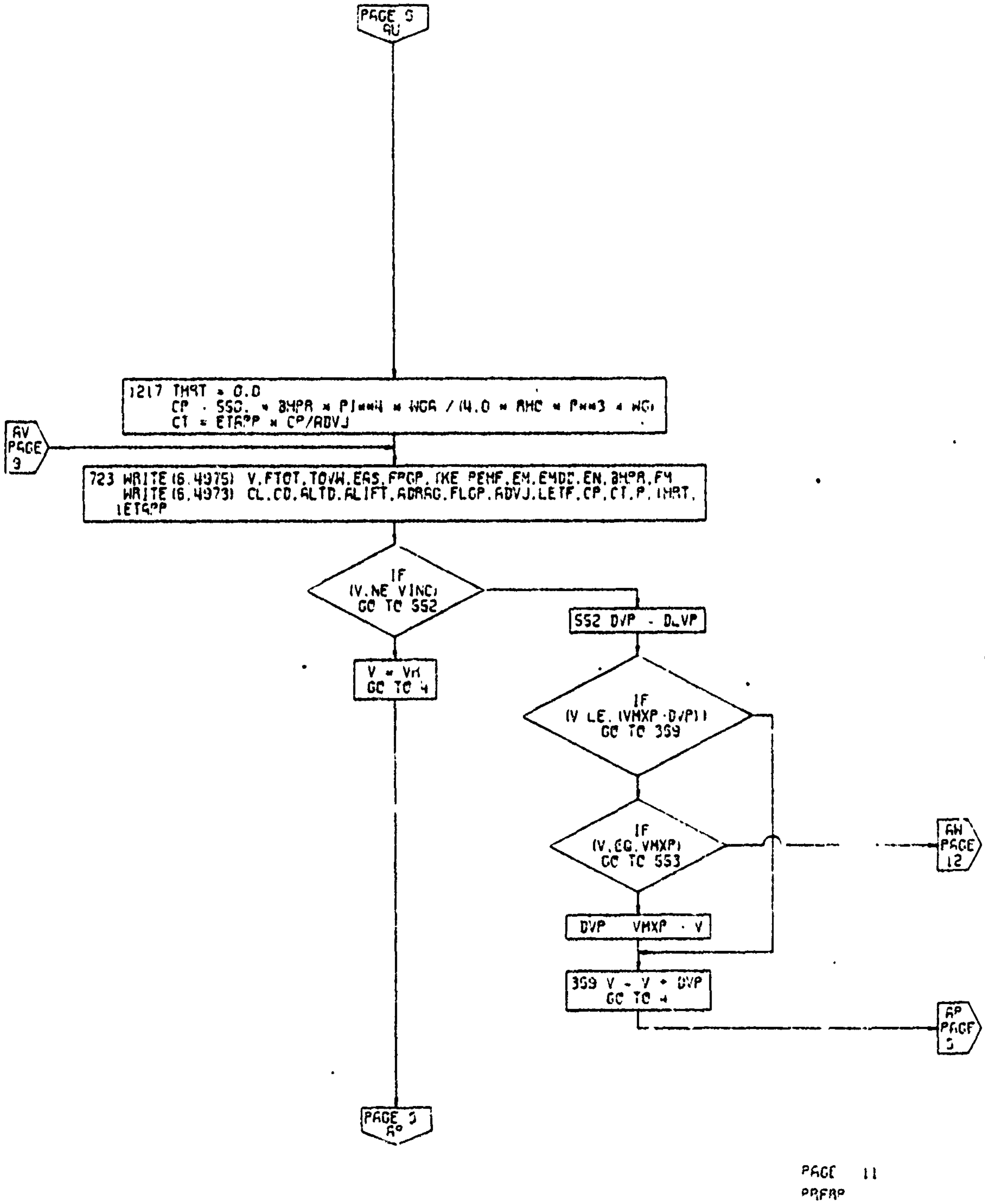


Figure 4-57. General Performance Subroutine, Flow Chart (Part 9 of 13)

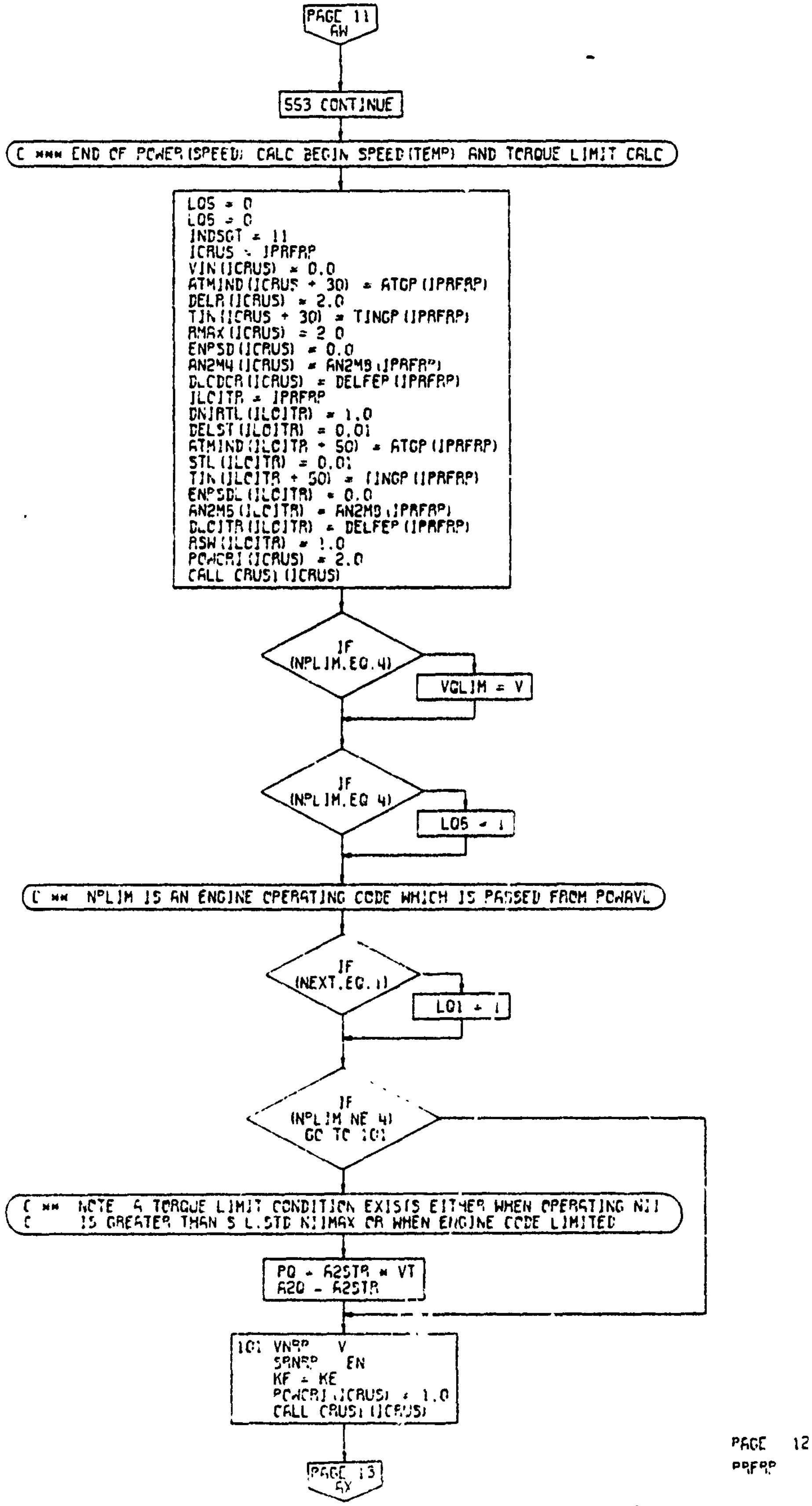


Figure 4-57. General Performance Subroutine, Flow Chart (Part 10 of 13)

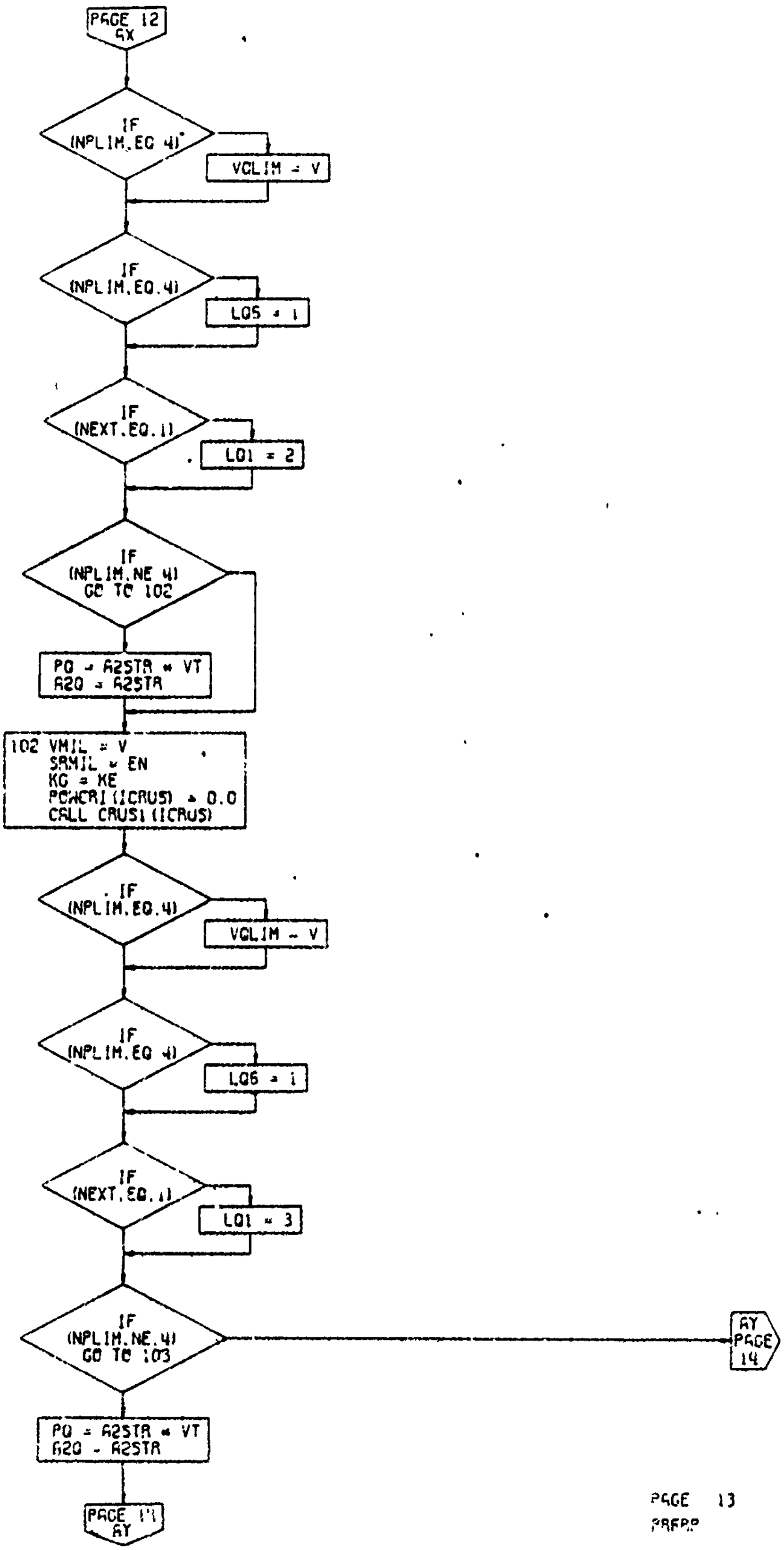


Figure 4-57. General Performance Subroutine, Flow Chart (Part 11 of 13)

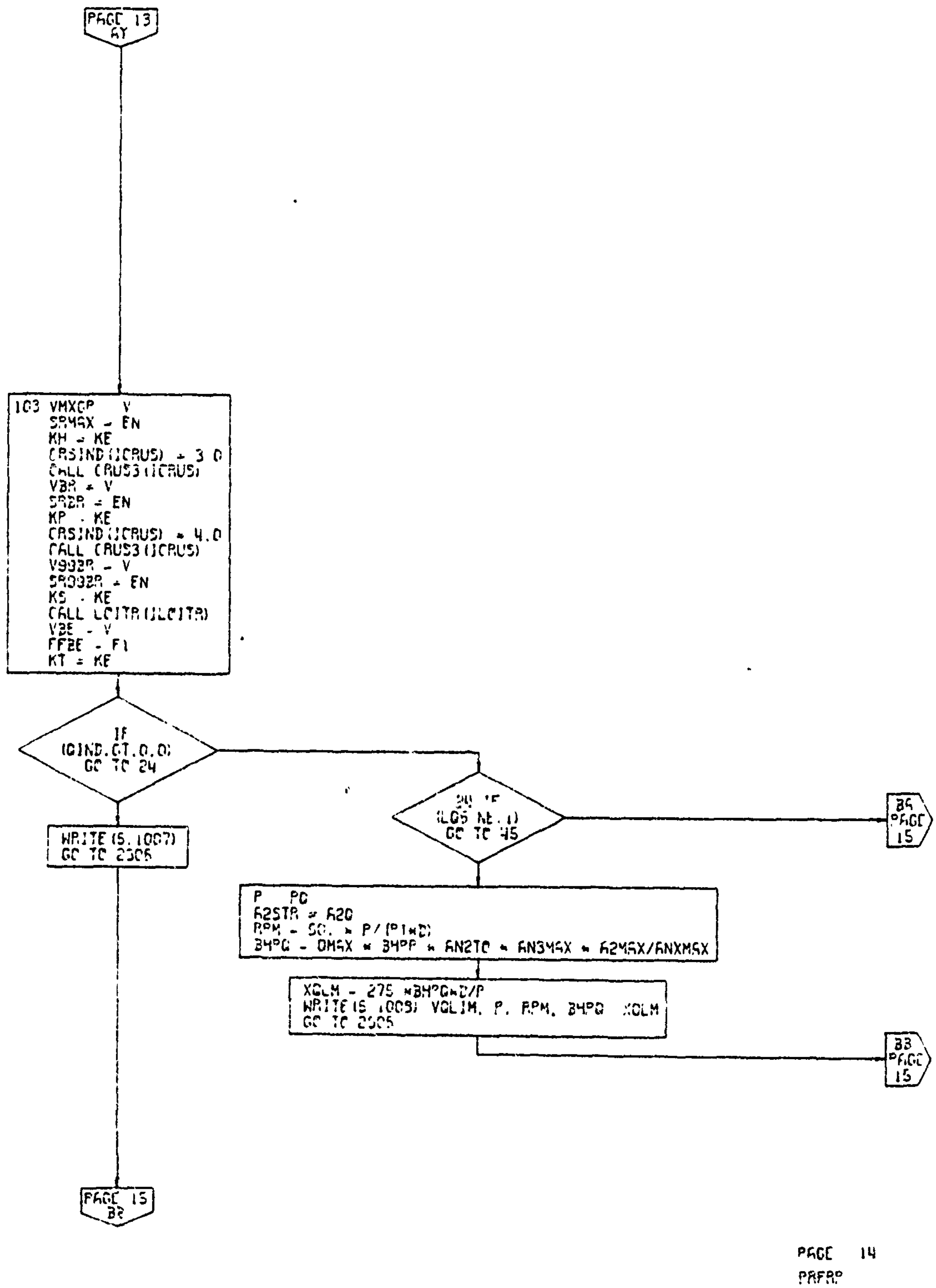


Figure 4-57. General Performance Subroutine, Flow Chart (Part 12 of 13)

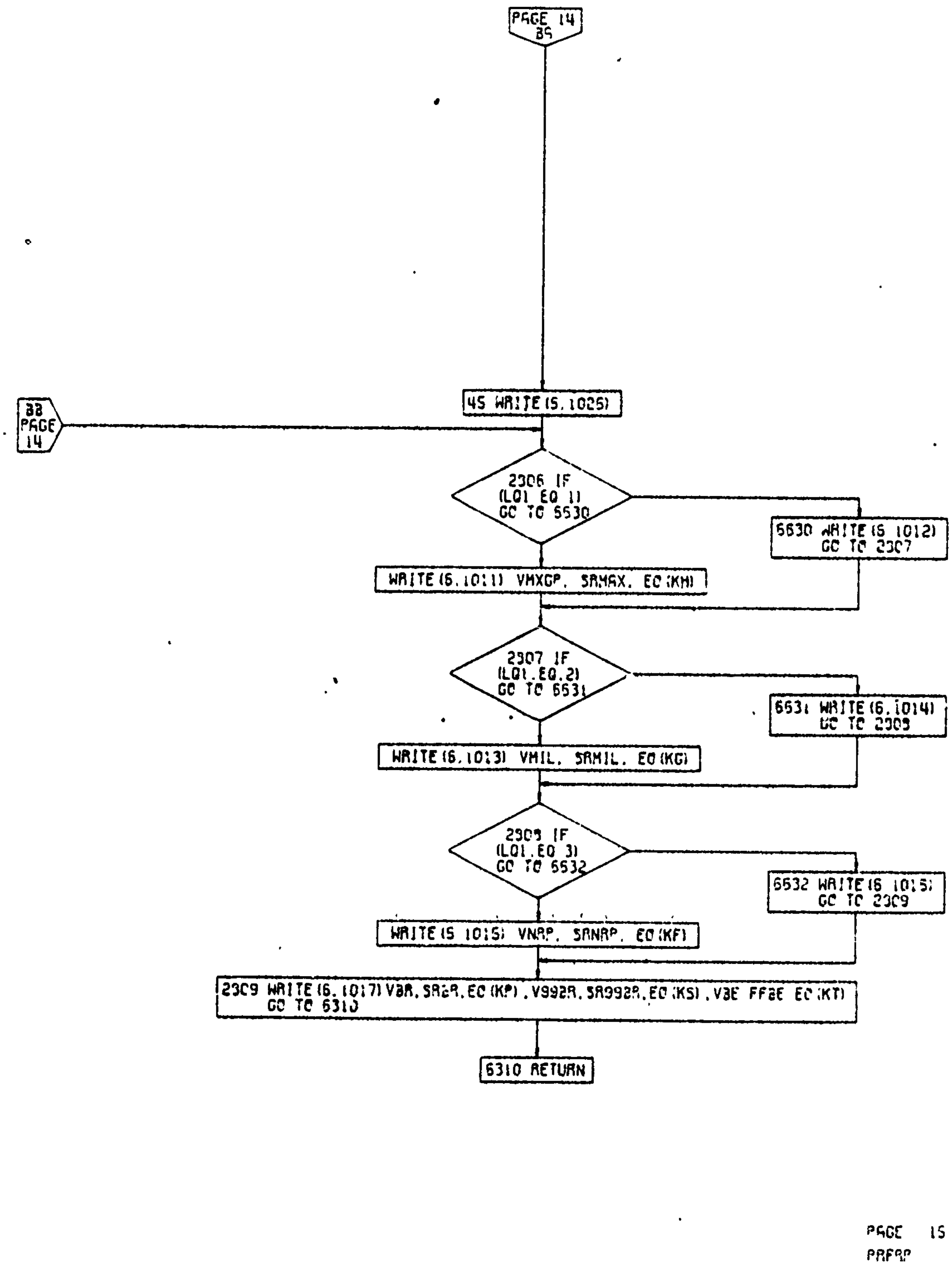


Figure 4-57. General Performance Subroutine,
Flow Chart (Part 13 of 13)

4.10.10 Function BIV

Function BIV is a two-dimensional Bivarian table look-up used to interpret values such as referred thrust or horsepower, referred fuel flow, and referred N_I and N_{II}. The BIV function performs a linear interpolation between two points on the ordinate and two points on the abscissa. A flow chart of the subroutine is shown in Figure 4-58.

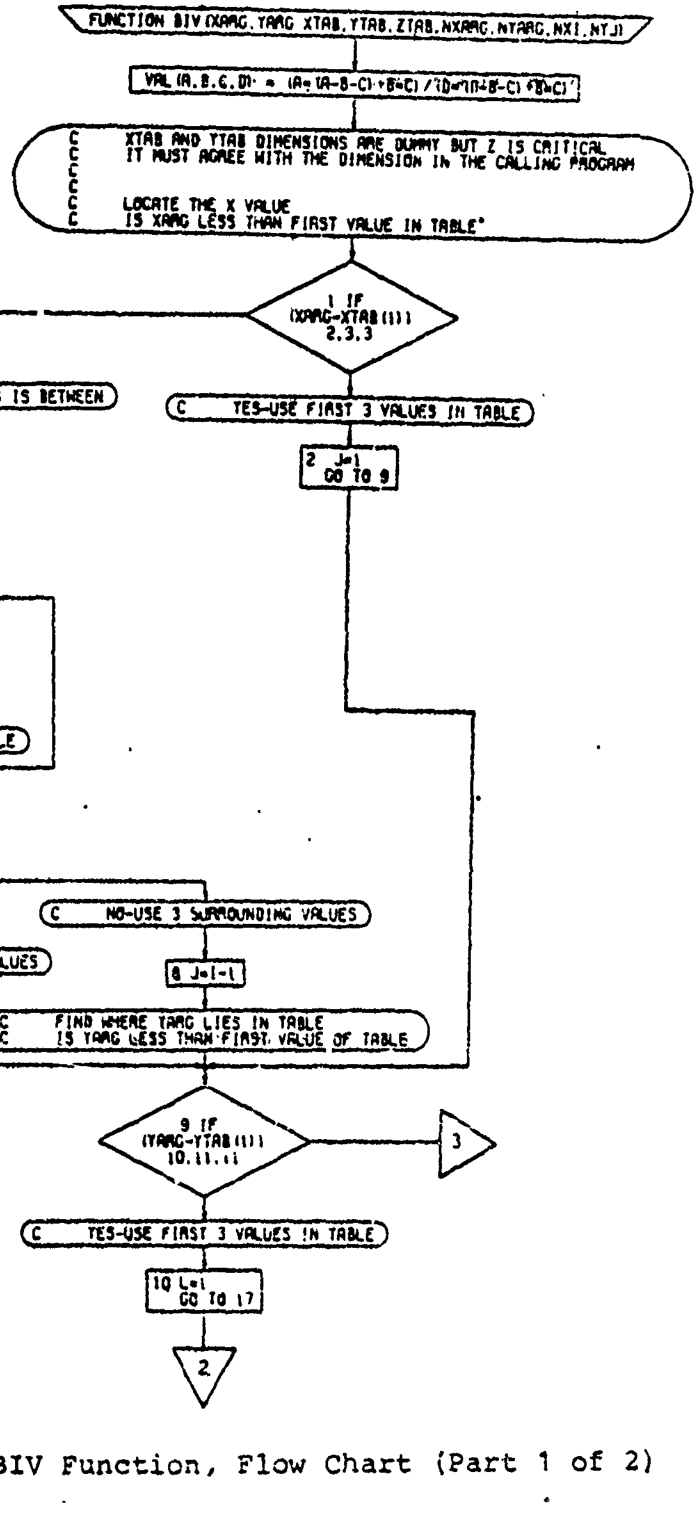


Figure 4-58. BIV Function, Flow Chart (Part 1 of 2)

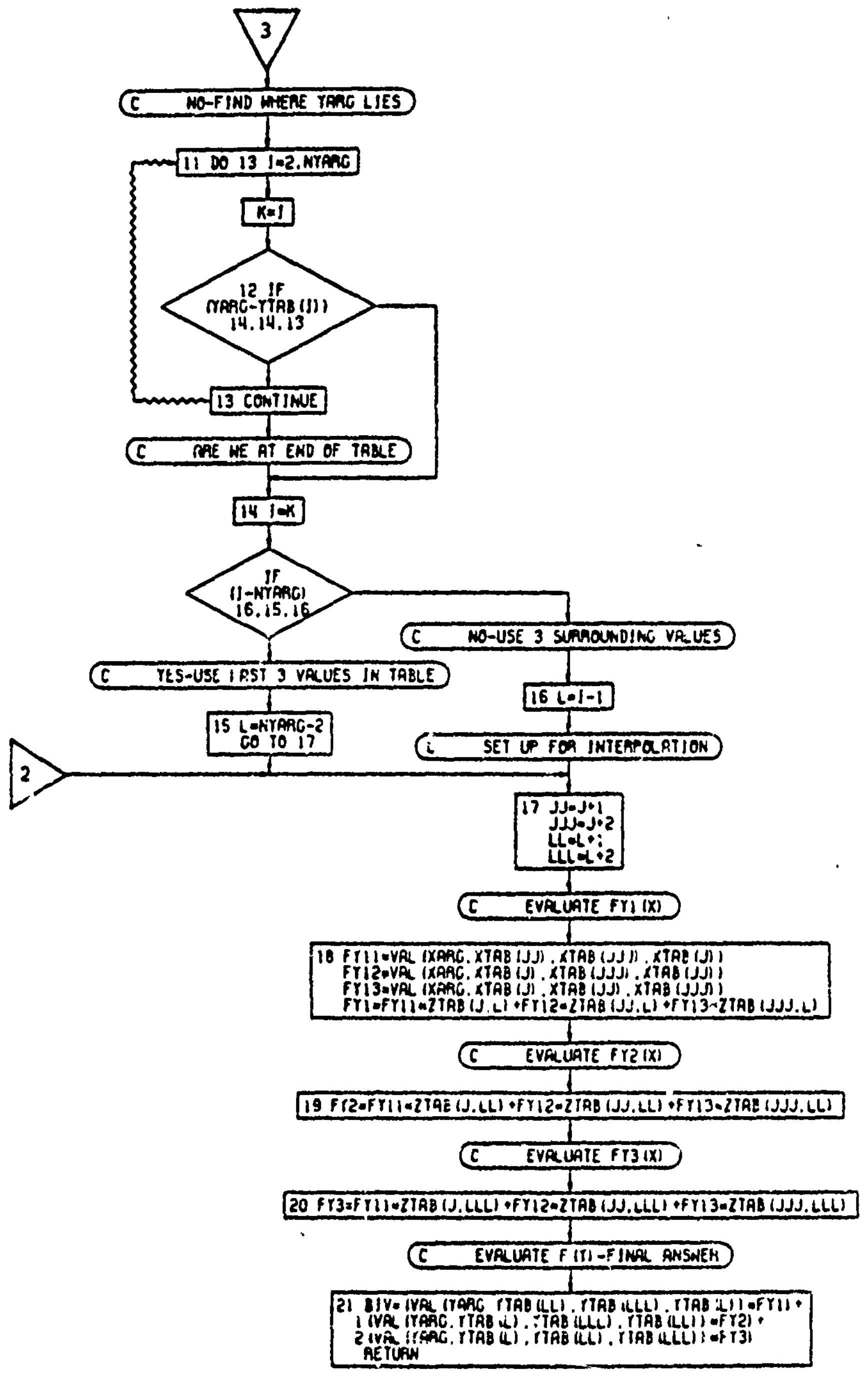


Figure 4-58. BIV Function, Flow Chart (Part 2 of 2)

4.10.11 Function PARA

PARA is a two-dimensional parabolic interpretation function used periodically throughout VASCOMP. A flow chart of the subroutine is shown in Figure 4-59.

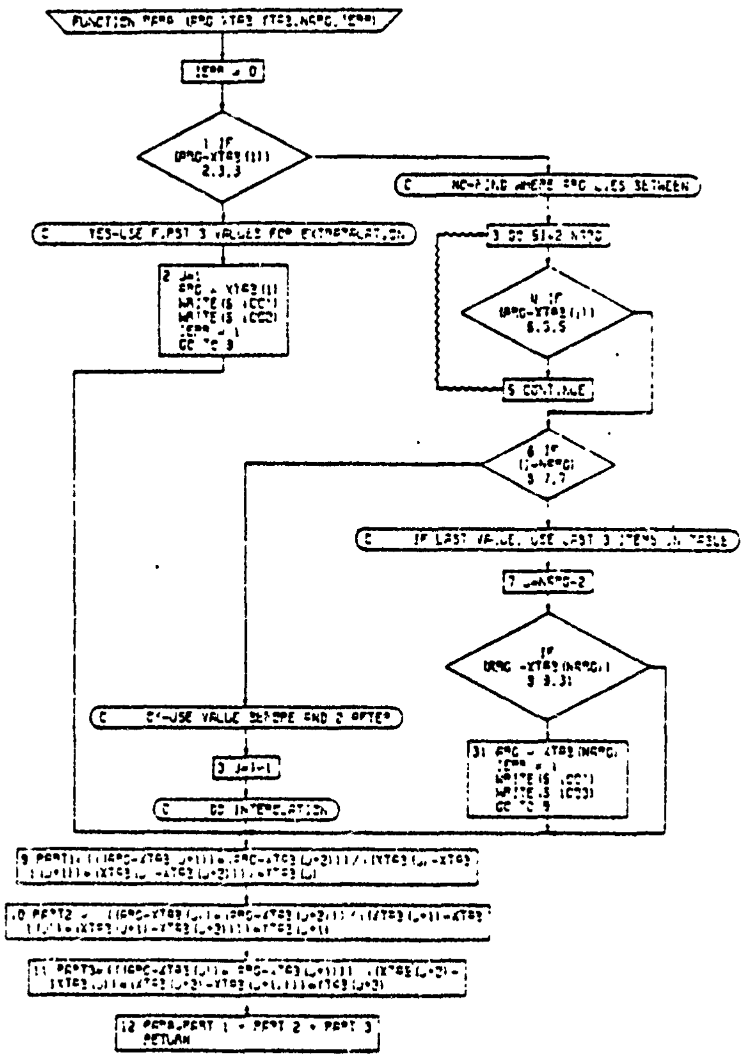


Figure 4-59. PARA Function, Flow Chart

4.10.12 Function Table

TABLE is a fourth-order Lagrangian interpolation function shown flowcharted in Figure 4-60.

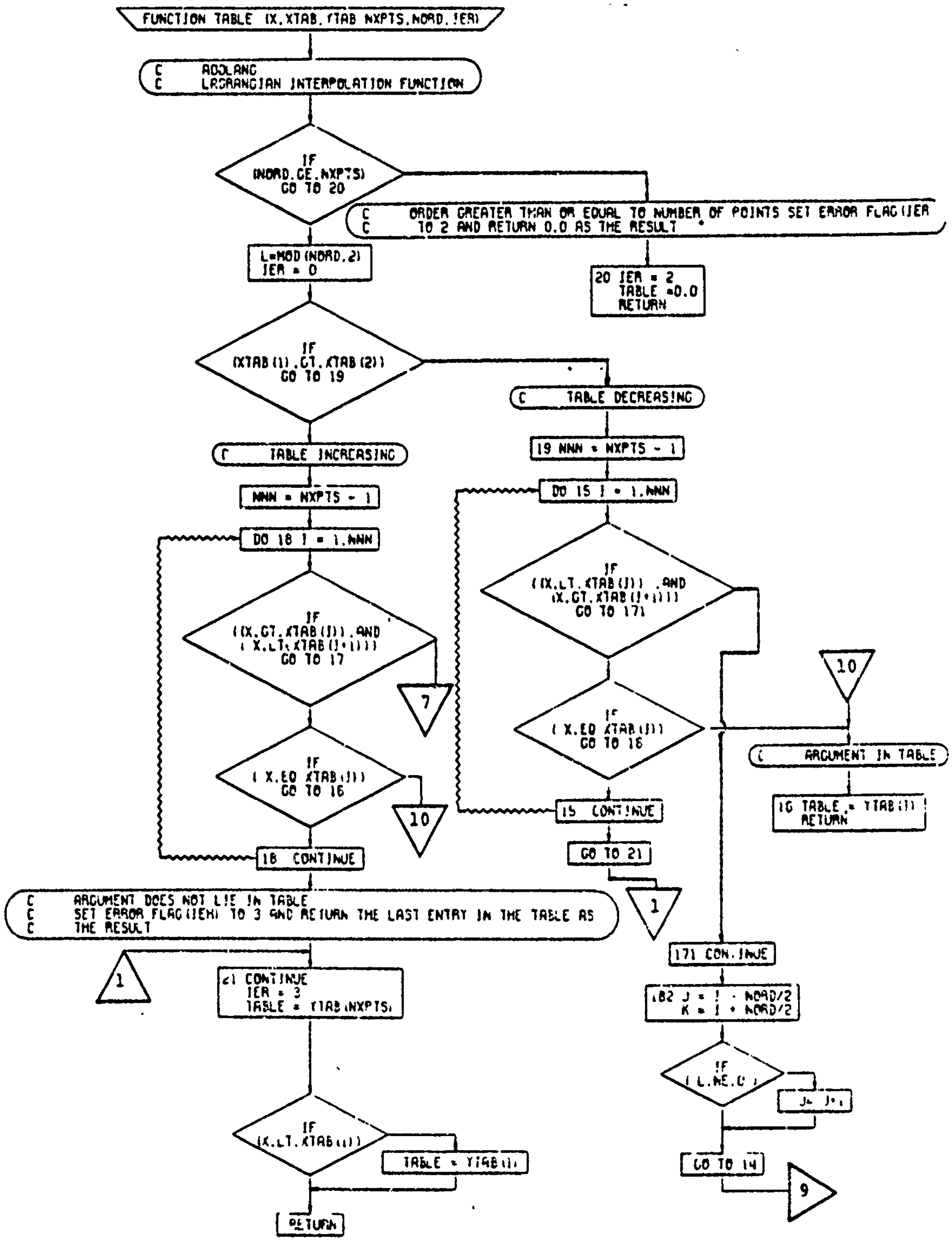


Figure 4-60. TABLE Function, Flow Chart (Part 1 of 2)

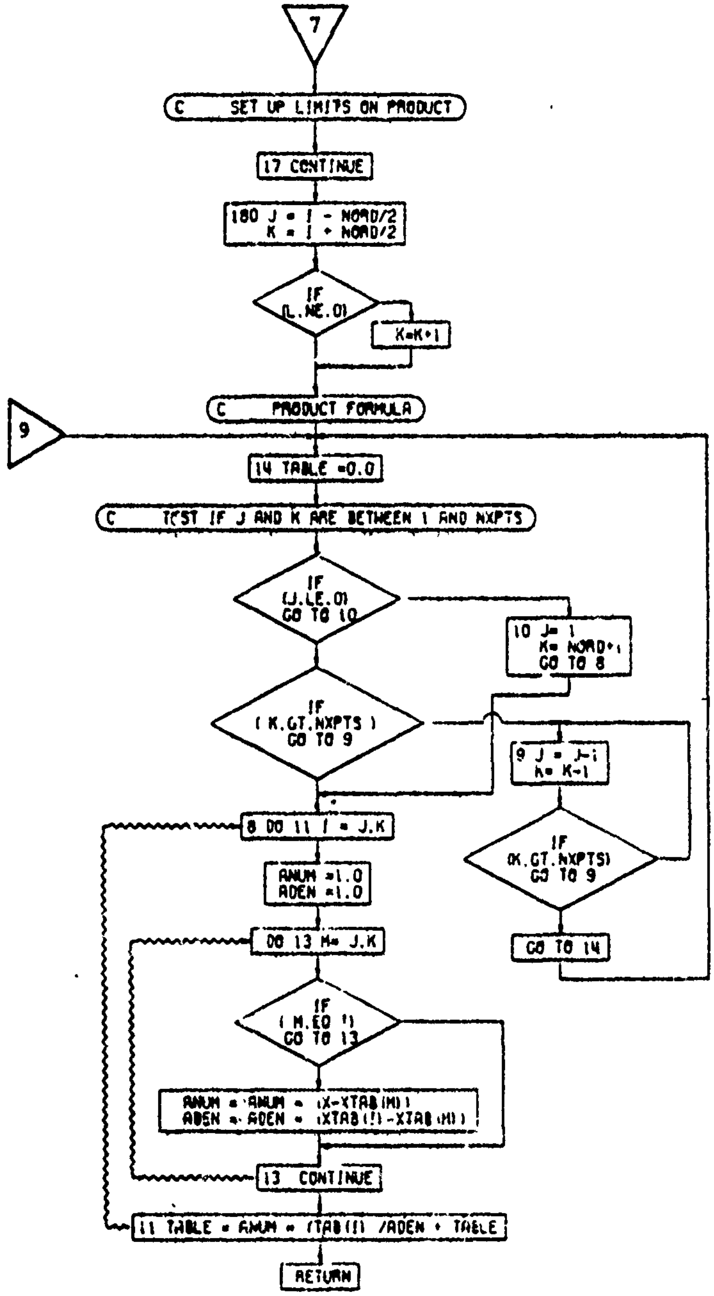


Figure 4-60. TABLE Function, Flow Chart (Part 2 of 2)

4.10.13 Function XLINT

XLINT performs a two-dimensional linear interpolation between two points. This subroutine is used extensively in subroutines ROTLIM and ROTPOW, and shown in flowchart form in Figure 4-61.

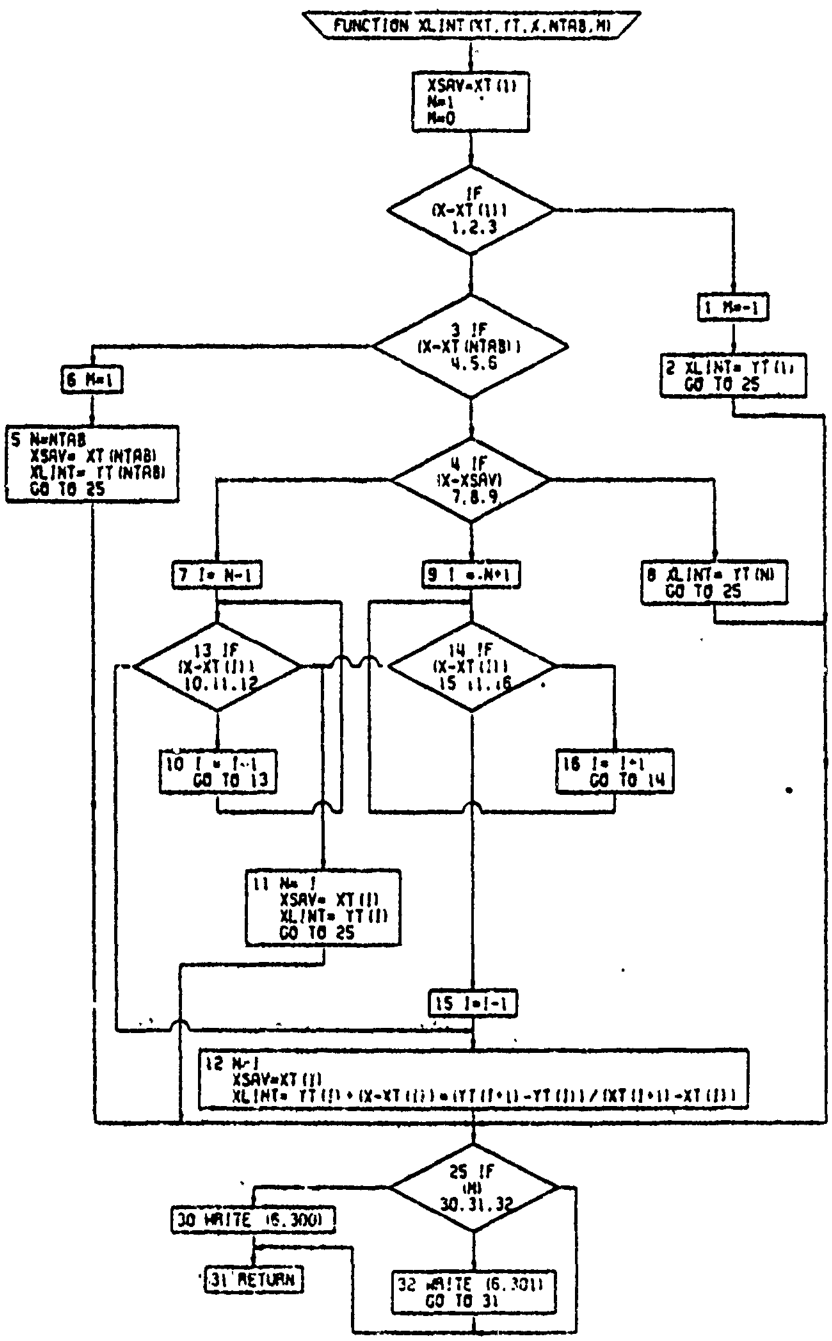


Figure 4-61. XLINT Function, Flow Chart

4.10.14 Function XLKUP

XLKUP is a double table parabolic look-up function. A flowchart of the subroutine is shown in Figure 4-62.

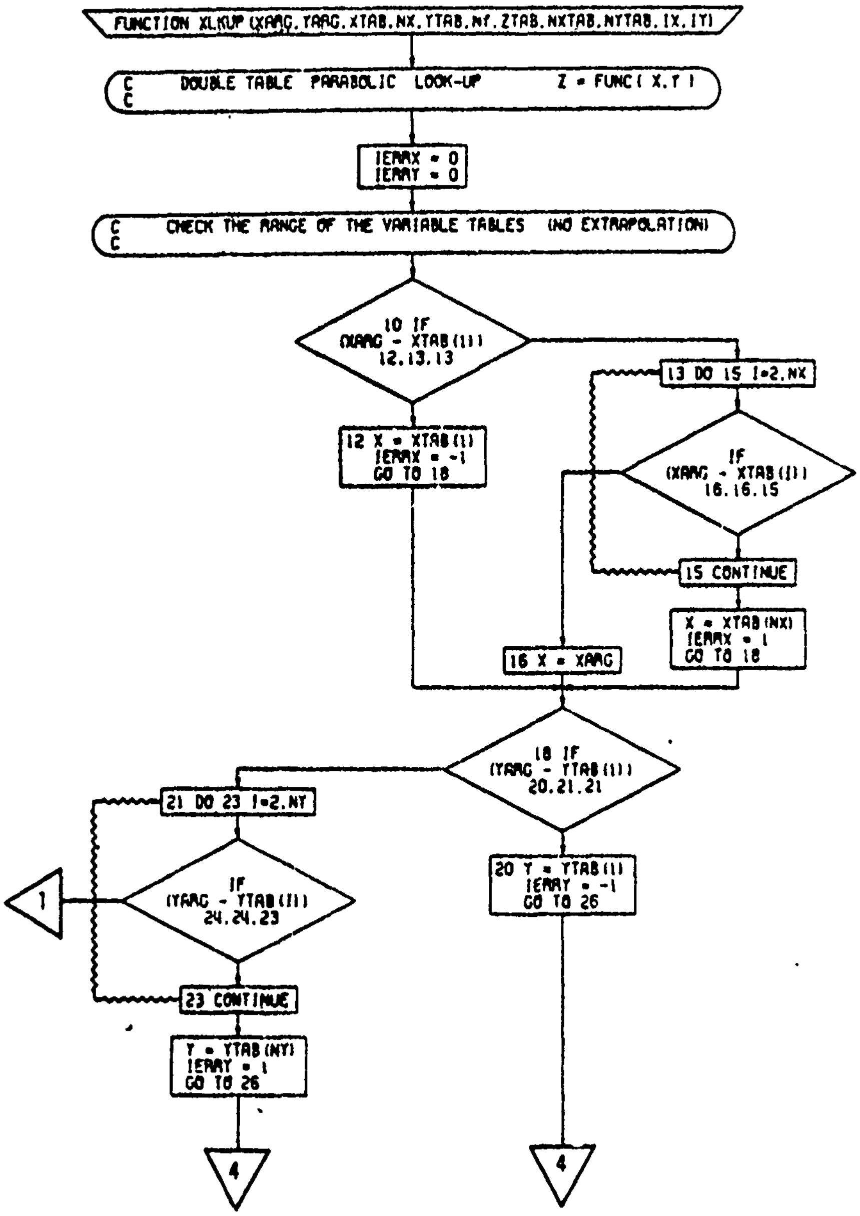


Figure 4-62. XLKUP Function, Flow Chart (Part 1 of 2)

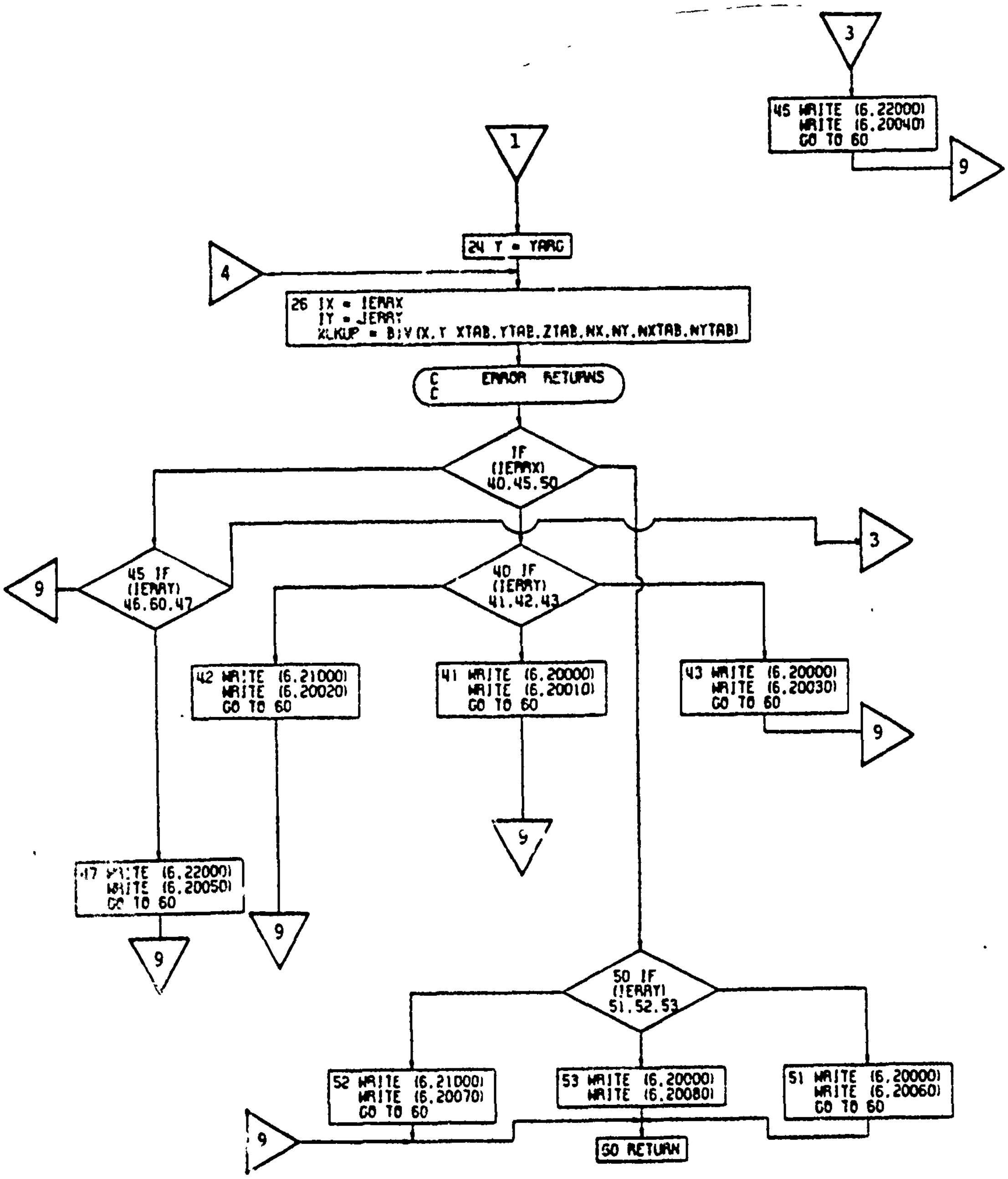


Figure 4-62. XLKUP Function, Flow Chart (Part 2 of 2)

4.10.15 Function XIBIV

XIBIV is an inverse double table parabolic look-up. A schematic of the flowchart is shown in Figure 4-63.

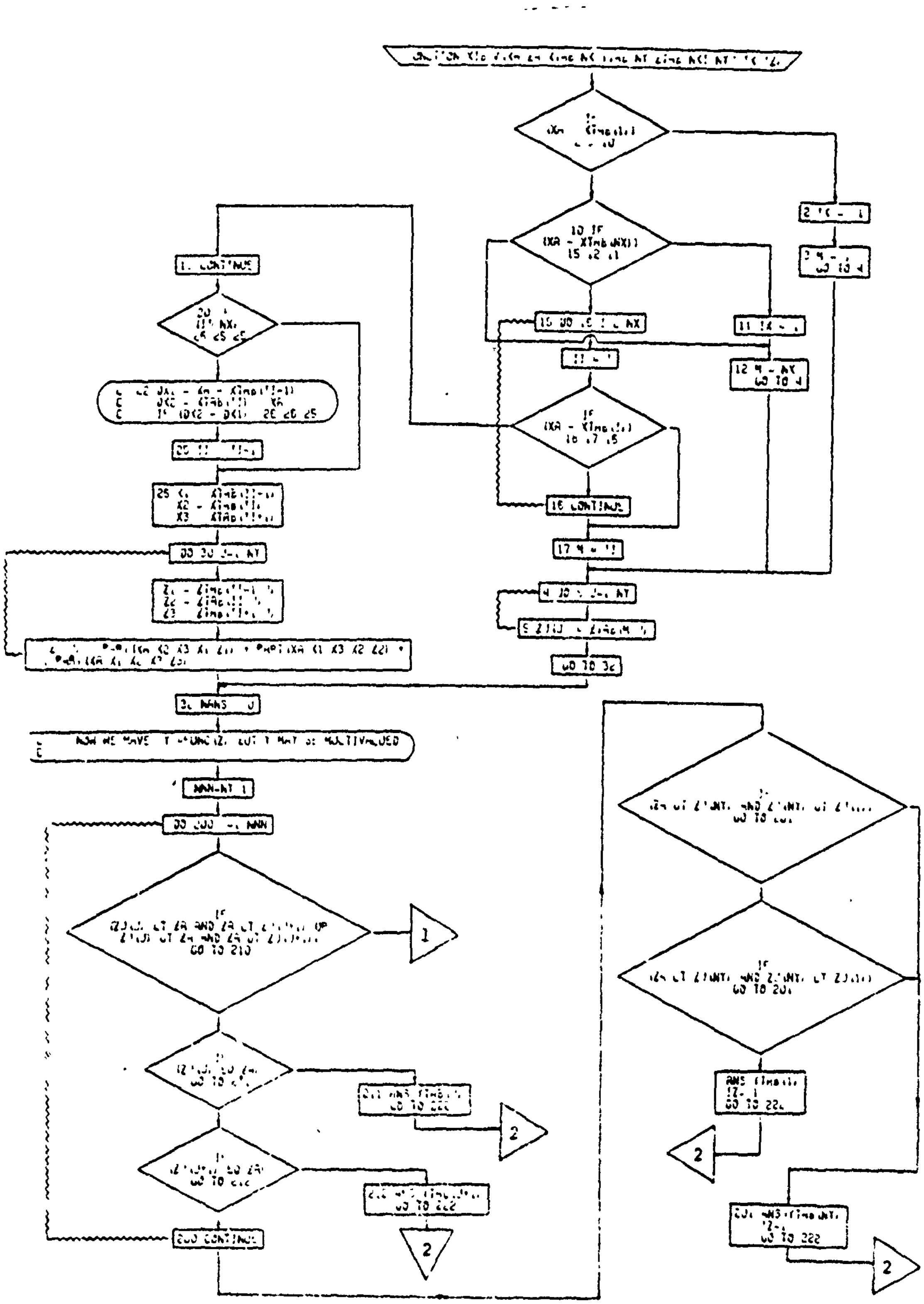


Figure 4-63. XIBIV Function, Flow Chart (Part 1 of 3)

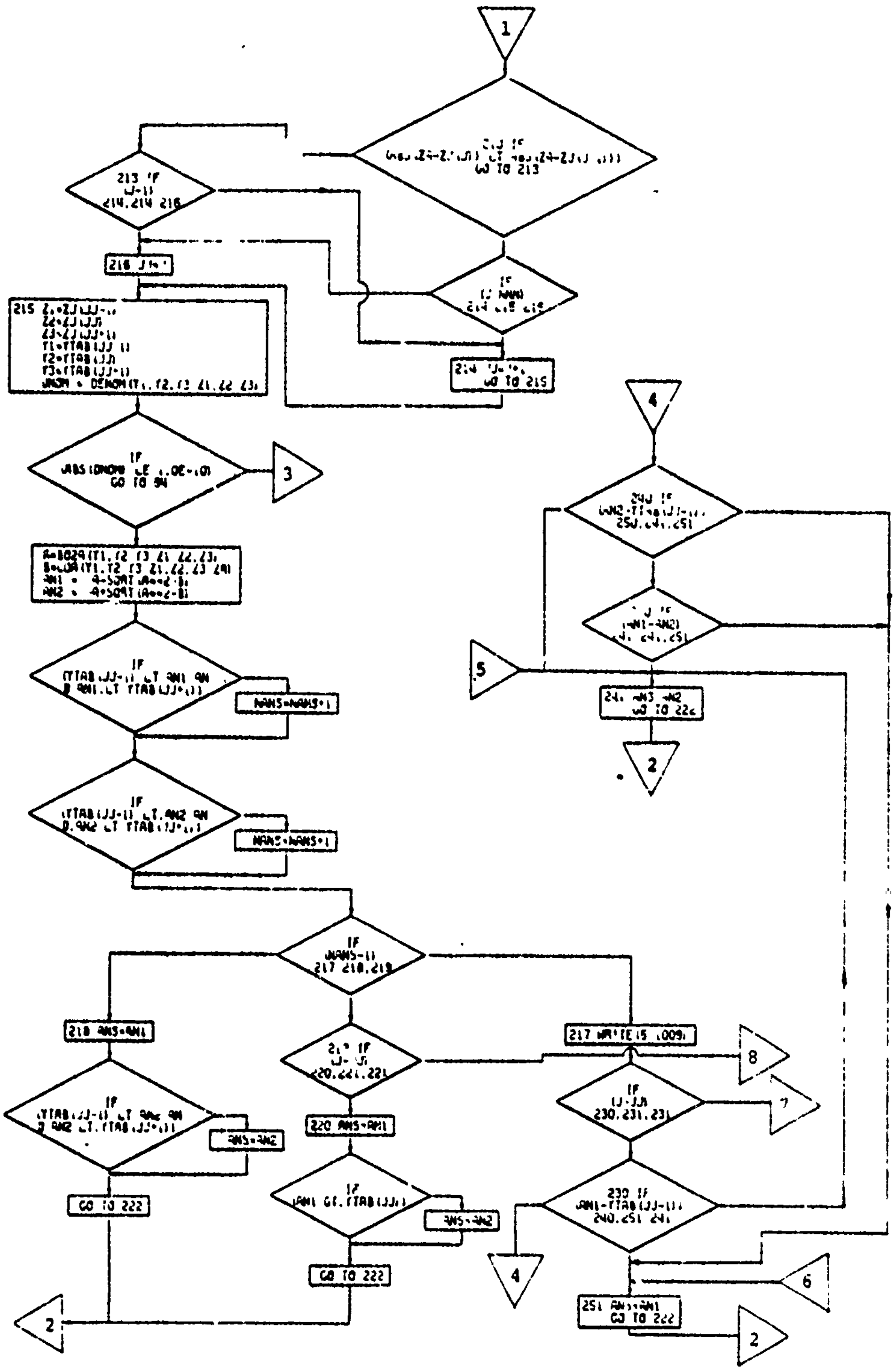


Figure 4-63. XIBIV Function, Flow Chart (Part 2 of 3)

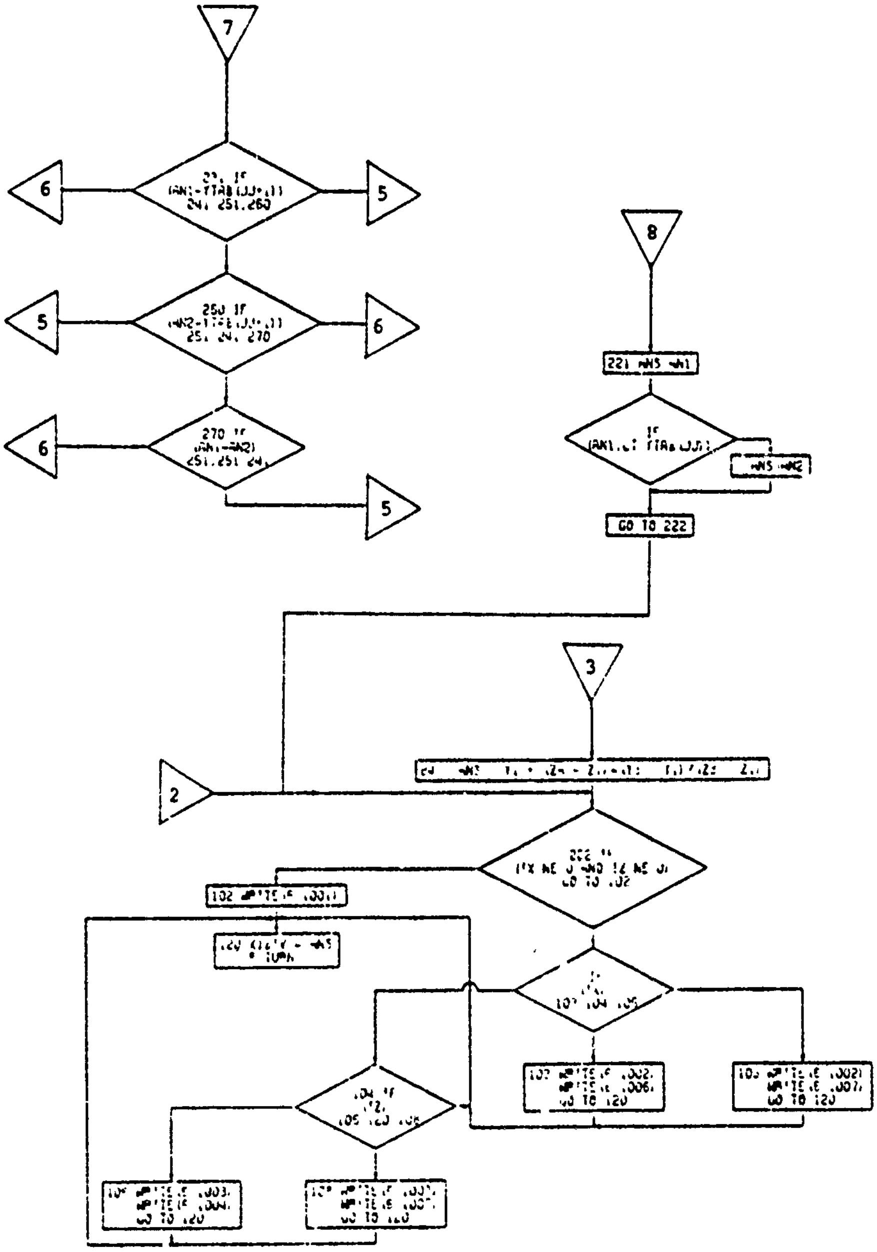


Figure 4-63. XIBIV Function, Flow Chart (Part 3 of 3)

5.0 PROGRAM INPUT

5.1 GENERAL

Input to the program is made by means of a standard set of input sheets. Although there are large quantities of possible input, necessitated by the requirement to keep the program flexible and general, the input sheets have been configured to give maximum visibility and reduce the tediousness of inputting the data. This has been accomplished through several means:

a. All input of a similar nature has been grouped together. Thus, all dimensional information is on the same input sheet, regardless of whether it is used in the size trends subroutine or elsewhere.

b. The input sheets have been color-coded to distinguish between the data required in the sizing option (OPTIND = 1) and the much smaller amount of data required for performance calculations (OPTIND = 2 or 3).

c. Footnotes on the input sheets call attention to input which is not required due to selection of one of the optional paths of computation.

d. For parametric studies where only one or two variables are being changed from case to case, a special supplementary input sheet may be used, thus reducing the quantity of paper work.

Altogether there are twenty-four different input sheets which can be loosely grouped into six categories: general information, aircraft descriptive information, mission profile information, engine cycle information, propeller data, and supplementary information. A specimen copy of each input sheet is included in this report on pages 5-5 to 5-51. Descriptions of input variables and indicators are given in sections 5.3.1 and 5.3.2. The use of the various input sheets is discussed below in 5.1.1 and 5.1.2.

5.1.1 General Information

Input all primary program indicators (except those for specific mission segments, such as CRSIND), mission

initial conditions, reserve fuel factors, and maneuver load factor.

5.1.2 Aircraft Description Information

5.1.2.1 Dimensional Information - Input characteristic geometric information for aircraft being studied.

5.1.2.2 Propulsion Information - Input data for propulsive efficiencies, numbers of engines, engine clusters, propellers, etc., and critical engine sizing conditions. There are four different input sheets for propulsion information - divided into one sheet for propeller data when using turboshaft engines and one sheet for each of the engine types which may be selected: turboshaft (ENGIND = 0), turbojet or turbofan (ENGIND = 1), and convertible (ENGIND = 2). Thus, the user need select only the input sheet(s) corresponding to the type of engine which he is using.

5.1.2.3 Aerodynamics Information - Input aircraft drag characteristics and wing section lift characteristics.

5.1.2.4 Weight Information - Input the factors and constants for weight trends calculations.

5.1.3 Mission Profile Information

There are 8 input sheets for mission profile information. They are:

a. Taxi Information
b. Takeoff, Hover, and Landing Information
c. Climb Information
d. Cruise Information
e. Descent Information
f. Loiter Information
g. Change of Weight and Transfer Altitude Information (incorporating change of fuel weight, change of payload weight, and transfer altitude)
h. General Performance

Each input variable on the mission profile sheets is represented by an array of ten input locations. The data for these locations is filled in sequentially by rows as the particular mission segment is used. For example, the first time that taxi is used in a particular case, the required input information is filled in on the first row of the input sheet. Data for the second taxi of a case is filled in on the second row, and so on. Thus, up to ten of any particular segment may be used in a case.

5.1.4 Engine Cycle Information

The engine cycle sheets may be used to input engine cycle data when one of the standard engine cycles is not used. The five engine cycle sheets are divided into standard performance information and nonstandard performance information. The standard performance data, of which there are three sheets (two for primary engines and one for lift engines), represent the performance of idealized engine cycles. These data are unlimited except for the effect of engine ratings, which are dictated by values of turbine temperature. The nonstandard performance represents limiting values of fuel flow, torque, rpm and other nonstandard effects.

5.1.5 Propeller Performance Data

The propeller performance sheets may be used to input a data for a specific propeller when using η_pIND = 1, or a specific fan using η_pIND = 3. The data is input as a table of C_P as a function of C_T and J.

5.1.6 Supplementary Information

The supplementary input sheet may be used for the second and subsequent cases of a parametric study. For example, if the user wishes to change both the wing loading (location 0106 - see dimensional information sheet) and the disc loading (location 0225 - see propulsion information sheet), these locations and their new values may be filled in on the supplementary input sheet.

Two typical problems, from input to output, are discussed in Section 7.3.

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SHEET NO.	CASE NO.
OF	

5.2 Specimen Input Sheets

GENERAL INFORMATION

TITLE CARD (72) (DIGITS): 7 10 13 16 19 22 25 28 31 34 37 40 42 / 43 46 49 52 55 58 61 64 67 70 73 76 78

NOTE: WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

	VARIABLE	UNIT	LOC.	VALUE	
OPTION INDICATOR	OPTIND		0001		1=SIZE AIRCRAFT; 2=PERFORMANCE ONLY; 3=FUEL ITERATION
PRINT INDICATOR	OPTIONAL PRINT		0002		0=STD. PRINT; 1=DETAILED PRINT
AERO DYNAMICS INDICATORS	DRGIND		0003		0= PROG CALC COMPRESS DRAG; 1= INPUT COMPRESS DRAG
	OSWIND		0004		0 INPUT e; 1 PROG CALC e
SIZE TREND INDICATORS	PDMIND		0005		1=INPUT PROP D, A; 2=INPUT PROP W_G/A, A; 3=INPUT PROP D, C_T/σ; 4=INPUT PROP W_G/A, C_T/σ
	FDMIND		0006		0=INPUT FUSELAGE DIMENSIONS; 1=PROG. CALC FUS. DIMENSIONS; 2=FUS. SIZED FOR PASSENGERS
	WDMIND	SEE NOTE 2 BELOW	0007		0=NO WING/PROP DEPENDENCE; 1 2 WING PROP DEPENDENCE
	HTIND		0008		1=INPUT TAIL VOL COEFFICIENT
	VTIND		0009		2 INPUT FIXED TAIL AREA
PROPULSION INDICATORS	FIXIND		0010		0=INPUT FIXED SIZE ENGINES; 1 PROGRAM SIZE ENGINES
	ENGIND		0011		0=TURBOSHAFT; 1=TURBOJET, TURBOFAN; 2=CONVERTIBLE
	ESZIND	SEE NOTE 1 BELOW	0010		0=SIZE FOR TAKEOFF ONLY; 1=SIZE FOR TAKEOFF OR CRUISE
	LFTIND		0013		0=NO LIFT ENGINES; 1=LIFT ENGINES
INITIAL CONDITIONS	WG_o	LBS	0014		GROSS WEIGHT
	h_o	FT	0015		ALTITUDE
	R_o	NM	0016		RANGE
	t_o	HR	0017		TIME
FLIGHT PATH CONTROL INDICATORS	h_{OPT} IND		0018		0=CRUISE @ SPECIFIED ALT.; 1=CRUISE @ OPTIMUM ALT.
	V_{LIM} IND		0019		0 NO CONSTRAINT ON EAS; 1 EAS ≤ 250 KTS @ h ≤ 10000
LIMITING SPEED	M_{MO}		0020		MACH NO.
	V_{MO}	KTS EAS	0021		EAS
	V_{DIVE}	KTS EAS	0022		
MANEUVER LOAD FACTOR	M_{LF}		0023		
RESERVE FUEL FACTORS	K_1		0024		NOM 1.0
	δW_f	LBS	0025		NOM. 0
	K_{FF}		0026		FUEL FLOW MULTIPLIER NOM 1.0

MISSION PROFILE INFORMATION
MAXIMUM OF 50 CONSECUTIVE SEGMENTS

VALUES OF SGTIND

100 - END OF CASE
0=END OF MISSION
1=TAXI
2=T.O., HOVER, LAND
3=CLIMB
4=CRUISE
5=DESCENT
6=LOITER
7=CHANGE FUEL
8=CHANGE PAYLOAD
9=TRANSFER ALTITUDE
10=X-Y PLOTTER OUTPUT
11=GENERAL PERFORMANCE

	LOC.	VALUE		LOC.	VALUE
1ST	0027		26TH	0052	
2ND	0028		27TH	0053	
3RD	0029		28TH	0054	
4TH	0030		29TH	0055	
5TH	0031		30TH	0056	
6TH	0032		31ST	0057	
7TH	0033		32ND	0058	
8TH	0034		33RD	0059	
9TH	0035		34TH	0060	
10TH	0036		35TH	0061	
11TH	0037		36TH	0062	
12TH	0038		37TH	0063	
13TH	0039		38TH	0064	
14TH	0040		39TH	0065	
15TH	0041		40TH	0066	
16TH	0042		41ST	0067	
17TH	0043		42ND	0068	
18TH	0044		43RD	0069	
19TH	0045		44TH	0070	
20TH	0046		45TH	0071	
21ST	0047		46TH	0072	
22ND	0048		47TH	0073	
23RD	0049		48TH	0074	
24TH	0050		49TH	0075	
25TH	0051		50TH	0076	

Note 1 ESZIND IS NOT REQUIRED IF FIXIND 0 OR

Note 2 IF WDMIND 1, CHORD-DIAMETER RATIO IS INPUT, WING LOADING IS CALCULATED
IF WDMIND 2 WING LOADING IS INPUT, CHORD-DIAMETER RATIO IS CALCULATED
DO NOT SET WDMIND 1,2 IF ENGIND 1

SHEET NO. OF	CASE NO.

AIRCRAFT DIMENSIONAL INFORMATION

NOTE: WHEN OPTIND = 2
CONSIDER ONLY THOSE
ITEMS IN THE SHADED BLOCKS

GROUP	NOTE	VARIABLE	UNIT	LOC.	VALUE
WING	a.	AR		0101	
	h.	$\overline{C/D}$		0102	
		i_W	DEG	0103	
		$(t/c)_R$		0104	
		$(t/c)_T$		0105	
	i.	W_G/S	PSF	0106	
	c.	$\Lambda_{c/4}$	DEG	0107	
		λ		0108	
HOR. TAIL		AR_{HT}		0109	
		a_H		0110	
		l_{TH}	FT	0111	
		$(t/c)_{HT}$		0112	
	j.	$\overline{V}_H$		0113	
		λ_H		0114	
	k.	S_{HT}		0115	
PROP.	g.	r		0116	
	b.	y_{CL}	FT	0117	
	b.	ζ_1		0118	
	b.	ζ_2		0119	
GENERAL		$\Delta S_{WET}/S_W$		0120	

GROUP	NOTE	VARIABLE	UNIT	LOC.	VALUE
BODY	d.	h_F	FT	0121	
	e.	l_F	FT	0122	
	d.	$(l/d)_P$		0123	
	d.	$(l/d)_{TAIL}$		0124	
	d.	$l_{CONST. DIA.}$	FT	0125	
		l_{RW}	FT	0126	
	e.	S_F	FT2	0127	
		w_F	FT	0128	
VERT. TAIL		AR_{VT}		0129	
		l_{TV}	FT	0130	
		$(t/c)_{VT}$		0131	
	l.	$\overline{V}_V$		0132	
		λ_V		0133	
	m.	S_{VT}		0134	
MAIN GEAR		y_{MG}		0135	
PRIM. ENG.		y_P		0136	
LIFT ENG.	f.	y_L		0137	
	f.	ϵ		0138	
PRIM. ENGINE NACELLE		γ_1		0139	
		γ_2		0140	
		γ_3		0141	

NOTE: **INPUT NOT NECESSARY WHEN:**

a. WDMIND = 1,2
b. WDMIND = 0
c. DRGIND = 1 & OPTIND = 2
d. FDMIND = 0,2
e. FDMIND = 1,2
f. LFTIND = 0
g. ENGIND = 1
h. WDMIND = 0,2
i. WDMIND = 1
j. HTIND = 2
k. HTIND = 1
l. VTIND = 2
m. VTIND = 1
n. FDMIND = 0
o. FDMIND = 2

PASSENGER DATA REQUIRED FOR FUSELAGE SIZING (FDMIND = 2)

VARIABLE	LOC.	VALUE	
GALLEY INDICATOR	0151		0 = PROG. CALC. GALL. SIZE 1 = INPUT GALLEY AREA
GALLEY AREA (FT^2)	0152		(SEE NOTE *a*)

VARIABLE	LOC.	VALUE	
LAVATORY INDICATOR	0159		0 = PROG. CALC. NO. OF LAVS. 1 = INPUT NO. OF LAVS.
NO. OF LAVS	0160		(SEE NOTE *b*)

1ST CLASS SERVICE

VARIABLE	LOC.	VALUE	TYPICAL VALUES
NO. OF PASSENGERS	0153		(SEE NOTE *c*)
SEATS ABREAST	0154		
NO. OF AISLES	0155		
UNIT SEAT WIDTH (IN.)	0156		27"
SEAT PITCH (IN.)	0157		38"
AISLE WIDTH (IN.)	0158		20"

TOURIST SERVICE

VARIABLE	LOC.	VALUE	TYPICAL VALUES
NO. OF PASSENGERS	0161		(SEE NOTE *c*)
SEATS ABREAST	0162		
NO. OF AISLES	0163		
UNIT SEAT WIDTH (IN.)	0164		20"
SEAT PITCH (IN.)	0165		34"
AISLE WIDTH (IN.)	0166		16"

NOTES:
a. GALLEY AREA IS NOT REQUIRED WHEN GALLEY INDICATOR = 0.
b. NUMBER OF LAVATORIES IS NOT REQUIRED WHEN LAVATORY INDICATOR = 0. LAVATORY AREA IS CALCULATED @ 16 FT^2 PER LAVATORY.
c. TYPICAL VALUES ARE SHOWN FOR GUIDANCE ONLY.

AIRCRAFT PROPULSION INFORMATION REQUIRED WHEN ENGIND = 0 (TURBOSHAFT ENGINES)

NOTE. WHEN OPTIND = 2 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

PRIMARY ENGINE CYCLE NO.	0201	

PRIMARY ENGINE DATA

NOTE	VARIABLE	UNIT	LOC.	VALUE
a	SHP^*_P	HP	0202	
	N_P		0204	

TRANSMISSION AND ACC DATA

NOTE	VARIABLE	UNIT	LOC.	VALUE
	η_T		0206	
h	XMSNIND		0257	
h	SHP_{XM}/SHP*		0258	
	ΔSHP_{ACC}	HP	0259	

FAN OR PROPELLER DATA

NOTE	VARIABLE	UNIT	LOC.	VALUE
	N_R		0223	
	V_{TIP}	FPS	0224	@ $N_{II} = N^*_{II}$
b	$W_{G/A}$	PSF	0225	ALWAYS REQ'D. IF OPTIND = 2 OR 3 †
c	DIA.	FT.	0226	†

TAKEOFF CONDITIONS FOR ENGINE AND TRANSMISSION SIZING (***)

NOTE	VARIABLE	UNIT	LOC.	VALUE
	h_{TO}	FT	0207	
	n		0208	
	ΔTin_{TO}	°F	0209	*
d	$\left(\frac{N_{II}}{N_{II\,MAX}}\right)_{TO}$		0210	
e	N_{PO}		0211	
e	N_{LO}		0212	
	SHP_E/SHP*		0260	
	$V_{R/C}$	FT/MIN	0261	
	K_{RC}		0262	

CRUISE CONDITIONS FOR ENGINE AND TRANSMISSION SIZING (††)

NOTE	VARIABLE	UNIT	LOC.	VALUE
f	POWIND		0213	**
f	h_C	FT	0214	
f	VC	KTS	0215	
f	ΔTin_C	°F	0216	*
g	$\left(\frac{N_{II}}{N_{II\,MAX}}\right)_C$		0217	

NOTE:

* FOR STANDARD ATMOSPHERE, INPUT $\Delta Tin = 0$

** POWIND: 0 = MAX. POWER
1 = MIL POWER
2 = NORMAL POWER

*** THESE LOCATIONS MUST BE INPUT IN FIXIND (LOC 0010) = 0

†† THESE LOCATIONS MUST BE INPUT IF XMSNIND = 1

NOTE: INPUT NOT NECESSARY WHEN

a. FIXIND = 1
b. OPTIND = 1 AND PDMIND = 1 OR 3
c. PDMIND = 2 OR 4
d. N2IND = 0,1
e. FIXIND = 0
f. FIXIND = 0 OR ESZIND = 0
g. N2IND = 0,1 OR FIXIND = 0 OR ESZIND = 0
h. ENGIND = 1

† INPUT FAN LOADING IF η_PIND = 3

† INPUT DIA = $(D_T^2 - D_R^2)^{1/2}$ IF η_PIND = 3

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PROPELLER DATA REQUIRED WHEN ENGIND = 0 (TURBOSHAFT ENGINES)

NOTE: WHEN OPTIND = 2 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

η_PIND	0200	

0 = INPUT η_P'S
1 = INPUT PROP. TABLE
2 = PROG. CALC. PROP. PERF. (1), (3)
3 = INPUT FAN TABLE

(0)

VALUES OF EFFICIENCY

	NOTE	VARIABLE	UNIT	LOC.	VALUE
TAKEOFF HOVER, LAND		η_{P2}		0232	
CLIMB		η_{P3}		0233	
DESCENT		η_{P5}		0234	

η_{P4}: CRUISE AND LOITER

NO. OF PAIRS IN η_{P4} TABLE	0245	

	LOC.	VALUE		LOC.	VALUE
VALUES OF M	0235		VALUES OF η_{P4}	0246	
	0236			0247	
	0237			0248	
	0238			0249	
	0239			0250	
	0240			0251	
	0241			0252	
	0242			0253	
	0243			0254	
	0244			0255	

η_PIND = 0

NOTE	VARIABLE	UNIT	LOC.	VALUE
a	$C_{T/\sigma}$		0227	
b	ACT. FACTOR PER BLADE		0228	
b	NO. OF BLADES		0229	

(1), (3)

η_PIND = 1,3

a	$C_{T/\sigma}$		0227	
b	ACT. FACTOR PER BLADE		0228	
b	NO. OF BLADES		0229	

η_{P5}	0234	
PROP. TABLE NO. (FAN TABLE NO.)	0256	

NOTE: ALSO INPUT PROP/FAN TABLE (LOCS. 1700 → 2142)

(2)

η_PIND = 2

a	$C_{T/\sigma}$		0227	
c	ACT. FACTOR PER BLADE		0228	

} ALWAYS REQ'D. IF OPTIND = 2 OR 3

NO. OF BLADES	0229	
C_{Li}	0230	
η_{P5}	0234	

NOTE: INPUT NOT NECESSARY WHEN

a. PDMIND = 1 OR 2
b. PDMIND = 3 OR 4
c. OPTIND = 1 AND PDMIND = 3 OR 4

AIRCRAFT PROPULSION INFORMATION REQUIRED WHEN ENGIND = 1 (TURBOJET OR TURBOFAN ENGINES)

NOTE: WHEN OPTIND = 2 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

PRIMARY ENGINE CYCLE NO.	0201	

PRIMARY ENGINE DATA

NOTE	VARIABLE	UNIT	LOC.	VALUE
a	F_N^*	LBS	0203	
	N_P		0204	

LIFT ENGINE CYCLE NO. (NOTE *c*)	0218	

LIFT ENGINE DATA

NOTE	VARIABLE	UNIT	LOC.	VALUE
b	F_{NL}^*	LBS	0219	
c	N_L		0220	
c	N_C		0221	

VALUES OF EFFICIENCY

TAKEOFF, HOVER, LAND

NOTE	VARIABLE	UNIT	LOC.	VALUE
c	η_L		0231	
	η_{P2}		0232	

NOTE: INPUT NOT NECESSARY WHEN

a. FIXIND = 1
b. FIXIND = 1 OR LFTIND = 0
c. LIFTIND = 0
d. N2IND = 0,1 OR FIXIND = 0
e. FIXIND = 0
f. FIXIND = 0 OR ESZIND = 0
g. N2IND = 0,1 OR FIXIND = 0 OR ESZIND = 0

	NOTE	VARIABLE	UNIT	LOC.	VALUE	
TAKEOFF CONDITIONS FOR ENGINE SIZING		h_{TO}	FT	0207		
		n		0208		
		ΔTin_{TO}	°F	0209		*
	d	$\left(\frac{N_{1I}}{N_{1I\ MAX}}\right)_{TO}$		0210		
	e	N_{PO}		0211		
	e	N_{LO}		0212		

THIS DATA IS ALWAYS REQ'D IF LFTIND = 1:

	NOTE	VARIABLE	UNIT	LOC.	VALUE	
CRUISE CONDITIONS FOR ENGINE SIZING	f	POWIND		0213		**
	f	h_C	FT	0214		
	f	VC	KTS	0215		
	f	ΔTin_C	°F	0216		*
	g	$\left(\frac{N_{1I}}{N_{1I\ MAX}}\right)_C$		0217		

NOTE:

* FOR STANDARD ATMOSPHERE, INPUT $\Delta Tin = 0$

** POWIND: 0 = MAX. POWER
1 = MIL POWER
2 = NORMAL POWER

	NOTE	VARIABLE	UNIT	LOC.	VALUE
DUCTED FAN DATA	†	η_{PIND}		0200	
		FAN TABLE NO		0256	

† MUST BE INPUT AS 3, ALSO INPUT FAN TABLE (LOCS. 1700 → 2142) $k_{R/P}$ (LOC 0457) MUST BE INPUT AS 0

FORM 49747 (5/80)

AIRCRAFT PROPULSION INFORMATION REQUIRED WHEN ENGIND = 2 (CONVERTIBLE ENGINES)

NOTE: WHEN OPTIND = 2 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

PRIMARY ENGINE CYCLE NO.	0201	

	NOTE	VARIABLE	UNIT	LOC.	VALUE
PRIMARY ENGINE DATA	a	F_N^*	LBS	0203	
		N_P		0204	
		β	LBS/HP	0205	
TRANSMISSION AND ACC DATA		η_T		0206	
	j	XMSNIND		0257	
	j	SHP_{XM}/SHP *		0258	
	j	ΔSHP_{ACC}	HP	0259	
PROPELLER DATA		N_R		0223	
		V_{TIP}	FPS	0224	
	b	$W_{G/A}$	PSF	0225	
	c	DIA.	FT.	0226	
	d	C_T/σ		0227	
	e	ACT. FACTOR PER BLADE		0228	
	e	NO. OF BLADES		0229	

FOR ROTOR SIZING (N_R, V_{TIP})

ALWAYS REQUIRED IF OPTIND = 2,3 ($W_{G/A}$, DIA.)

VALUE OF EFFICIENCY

	NOTE	VARIABLE	UNIT	LOC.	VALUE
TAKEOFF, HOVER, LAND		η_{P2}		0232	

	NOTE	VARIABLE	UNIT	LOC.	VALUE	
TAKEOFF CONDITIONS FOR ENGINE AND TRANSMISSION SIZING (†)		h_{TO}	FT.	0207		
		n		0208		
		ΔTin_{TO}	°F	0209		*
	f	$\left(\frac{N_{II}}{N_{II\,MAX}}\right)_{TO}$		0210		
	g	N_{PO}		0211		
	g	N_{LO}		0212		
		SHP_E/SHP *		0260		
		$V_{R/C}$	FT/MIN	0261		
		K_{RC}		0262		
CRUISE CONDITIONS FOR ENGINE SIZING	h	POWIND		0213		**
	h	h_C	FT.	0214		
	h	VC	KTS	0215		
	h	ΔTin_C	°F	0216		*
	i	$\left(\frac{N_{II}}{N_{II\,MAX}}\right)_C$		0217		

NOTE:

* FOR STANDARD ATMOSPHERE, INPUT Δ Tin = 0

** POWIND: 0 = MAX. POWER
1 = MIL POWER
2 = NORMAL POWER

† THESE LOCATIONS MUST BE INPUT IF FIXIND (LOC 0010) = 0

NOTES: INPUT NOT NECESSARY WHEN:

a. FIXIND = 1
b. PDMIND = 1 OR 3
c. PDMIND = 2 OR 4
d. PDMIND = 1 OR 2
e. PDMIND = 3 OR 4
f. N2IND = 0,1 OR FIXIND = 0
g. FIXIND = 0
h. FIXIND = 0 OR ESZIND = 0
i. N2IND = 0,1 OR FIXIND = 0 OR ESZIND = 0
j. ENGIND = 1

FORM 49748 (5/60)

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VASCOMP II V/STOL AIRCRAFT SIZING AND PERFORMANCE COMPUTER PROGRAM B-93

AIRCRAFT AERODYNAMICS INFORMATION

SHEET NO. OF	CASE NO.

NOTE: WHEN OPTIND = 2 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

NOTE	VARIABLE	LOC.	VALUE
	C_{DVTi}	0301	
	C_{DHTi}	0302	
	C_{DNi}	0303	
a	C_{DLNi}	0304	
	ΔC_D	0305	
b	e	0306	
	Δf_e FT2	0307	

NOTE	VARIABLE	LOC.	VALUE
	K_{LN}	0311	
	K_W	0312	
	K_N	0313	
	K_F	0314	
	K_{VT}	0315	
	K_{HT}	0316	

NOTE	VARIABLE	LOC.	VALUE
	$(Re/\ell)_i$	0330	
	$C_{\ell\alpha}$ RAD^{-1}	0331	
	α_{LO} DEG	0332	
c	$(x/c)_{PS}$	0333	
c	$(x/c)_{max\,t/c}$	0334	

WING PROFILE DRAG AS FUNCTION OF C_L

NO. OF PAIRS IN TABLE	LOC.	VALUE
	0308	

NOTE	VARIABLE	LOC.	VALUE
	C_L (1)	0317	
	C_L (2)	0318	
	C_L (3)	0319	
	C_L (4)	0320	
	C_L (5)	0321	
	C_L (6)	0322	
	C_L (7)	0323	
	C_L (8)	0324	

NOTE	VARIABLE	LOC.	VALUE
	C_{DWi} (1)	0335	
	C_{DWi} (2)	0336	
	C_{DWi} (3)	0337	
	C_{DWi} (4)	0338	
	C_{DWi} (5)	0339	
	C_{DWi} (6)	0340	
	C_{DWi} (7)	0341	
	C_{DWi} (8)	0342	

COMPRESSIBILITY DRAG AS A FUNCTION OF M AND C_L (Note d)

TABLE OF $\Delta C_{DM} = f(M, C_L)$

	LOC.	VALUE
NUMBER OF M	0309	
NUMBER OF C_L	0310	

VALUES OF M		
M_1	0325	
M_2	0326	
M_3	0327	
M_4	0328	
M_5	0329	

VALUES OF C_L		
C_L (1)	0343	
C_L (2)	0344	
C_L (3)	0345	
C_L (4)	0346	
C_L (5)	0347	
C_L (6)	0348	
C_L (7)	0349	

VALUES OF ΔC_{DM}

	M_1 =		M_2 =		M_3 =		M_4 =		M_5 =	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
C_{L1} =	0350		0357		0364		0371		0378	
C_{L2} =	0351		0358		0365		0372		0379	
C_{L3} =	0352		0359		0366		0373		0380	
C_{L4} =	0353		0360		0367		0374		0381	
C_{L5} =	0354		0361		0368		0375		0382	
C_{L6} =	0355		0362		0369		0376		0383	
C_{L7} =	0356		0363		0370		0377		0384	

NOTE: INPUT NOT NECESSARY WHEN: *a.* LFTIND = 0 *c.* DRGIND = 1

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SHEET NO.	CASE NO.
OF	

WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

AIRCRAFT WEIGHT INFORMATION

	VARIABLE	LOC	VALUE
†	OWE	0400	
	W_{FE} LBS	0401	
	W_{FUL} LBS	0402	
††	W_{PL} LBS	0403	

INCREMENTAL GROUP WTS. NOM = 0

VARIABLE	LOC	VALUE
ΔW_{FC} LBS	0417	
ΔW_{P} LBS	0418	
ΔW_{ST} LBS	0419	

VARIABLE	LOC	VALUE
ΔP P.S.I.	0450	
W_C LBS.	0451	
Y_C	0452	

FLIGHT CONTROLS

k_{CC}	0404	
k_{FW}	0405	
k_H	0406	
k_{SAS}	0407	
k_{TM}	0408	
k_{UC}	0409	

† OWE IS NOT NECESSARY WHEN OPTIND = 1,2

†† W_{PL} IS NOT NECESSARY WHEN OPTIND = 2

GROUP WEIGHT INFORMATION

STRUCTURAL

	k_B	0420	
*	k_{LES}	0421	
	k_{LG}	0422	
	k_{MG}	0423	
	k_{TL}	0424	
	k_{WF}	0425	
	k_{WW}	0426	
	k_Y	0427	
	k_Z	0428	
	k_{PES}	0429	
	k_{MT}	0430	
	k_{NAC}	0431	
	ℓ_{MT}	0432	

PROPULSION

**	k_{DS}	0453	
	k_{FS}	0454	
*	k_{LEI}	0455	
	k_{PEI}	0456	
**	(†)$k_{R/P}$	0457	
**	k_{VT}	0458	

* NOT NECESSARY WHEN LFTIND = 0

** NOT NECESSARY WHEN ENGIND = 1

(†) INPUT AS 0 IF η_{PIND} (LOC 0200) = 3

TO USE k_{MT}, k_{NAC}, & ℓ_{MT} INPUT k_{PES}=0
IF k_{PES} IS INPUT AS NON-ZERO, k_{MT}, k_{NAC}, AND ℓ_{MT} ARE NOT REQUIRED.

MULTIPLICATIVE FACTORS NOMINALLY = 1.0

K_{15}	0410	
K_{16}	0411	
K_{17}	0412	
K_{18}	0413	
K_{19}	0414	
K_{20}	0415	

K_8	0433	
K_9	0434	
K_{10}	0435	
K_{11}	0436	
K_{12}	0437	
K_{13}	0438	
K_{14}	0439	

K_2	0459	
K_3	0460	
K_4	0461	
K_5	0462	
K_6	0463	
K_7	0464	
K_{21}	0465	

ATMOSPHERE TEMPERATURE

NO. OF PAIRS	0416	

NOTE: THIS TABLE IS NOT NECESSARY IF ATMIND IS NEVER SET TO 2

h_1 FT	0440	
h_2 FT	0441	
h_3 FT	0442	
h_4 FT	0443	
h_5 FT	0444	
h_6 FT	0445	
h_7 FT	0446	
h_8 FT	0447	
h_9 FT	0448	
h_{10} FT	0449	

θ_1	0466	
θ_2	0467	
θ_3	0468	
θ_4	0469	
θ_5	0470	
θ_6	0471	
θ_7	0472	
θ_8	0473	
θ_9	0474	
θ_{10}	0475	

FORM 49744 (5/80)

SHEET NO. OF	CASE NO.

TAXI INFORMATION

SGTIND = 1

ATMIND

	LOC	VALUE
1ST	0501	
2ND	0502	
3RD	0503	
4TH	0504	
5TH	0505	
6TH	0506	
7TH	0507	
8TH	0508	
9TH	0509	
10TH	0510	

0 = STD, ATMOSPHERE
1 = STD. + ΔTin
2 = ARBITRARY θ(h)

ΔTin (°F) (NOTE *a*)

LOC	VALUE
0521	
0522	
0523	
0524	
0525	
0526	
0527	
0528	
0529	
0530	

$N_{II}/N_{II\ MAX}$ (NOTE *b*)

LOC	VALUE
0541	
0542	
0543	
0544	
0545	
0546	
0547	
0548	
0549	
0550	

t_T (HR)

	LOC	VALUE
1ST	0511	
2ND	0512	
3RD	0513	
4TH	0514	
5TH	0515	
6TH	0516	
7TH	0517	
8TH	0518	
9TH	0519	
10TH	0520	

k_{FL}

LOC	VALUE
0531	
0532	
0533	
0534	
0535	
0536	
0537	
0538	
0539	
0540	

NOTE: *a*. INPUT NOT NECESSARY WHEN ATMIND = 0, 2
b. INPUT NOT NECESSARY WHEN N2IND = 0, 1

NOTE: WHEN OPTIND = 2 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

VASCOMP II V/STOL AIRCRAFT SIZING AND PERFORMANCE COMPUTER PROGRAM B-93

SHEET NO.	CASE NO.
OF	

TAKE OFF, HOVER AND LANDING INFORMATION

SGTIND = 2

	TOLIND (NOTE *a*) LOC.	VALUE	ATMIND LOC.	VALUE	ΔTin (°F) (NOTE *b*) LOC.	VALUE	n_T (NOTE *c*) LOC.	VALUE	$N_{II}/N_{II\,MAX}$ (NOTE *d*) LOC.	VALUE
1ST	0601		0611		0631		0651		0671	
2ND	0602		0612		0632		0652		0672	
3RD	0603		0613		0633		0653		0673	
4TH	0604		0614		0634		0654		0674	
5TH	0605		0615		0635		0655		0675	
6TH	0606		0616		0636		0656		0676	
7TH	0607		0617		0637		0657		0677	
8TH	0608		0618		0638		0658		0678	
9TH	0609		0619		0639		0659		0679	
10TH	0610		0620		0640		0660		0680	

0 = STANDARD ATMOSPHERE
1 = STD. + ΔTin
2 = ARBITRARY θ(h)

1 = INPUT REQ'D n_T; AIRPLANE WILL USE MAX. POWER FROM LIFT ENGINES BEFORE AUGMENTING WITH PRIMARY ENGINES OR - WILL USE ONLY PRIMARY ENGINES IF LFTIND = 0.

2 = INPUT REQ'D n_T; AIRPLANE WILL TAKE EQUAL FRACTION OF POWER FROM LIFT AND PRIMARY ENGINES.

3 = INPUT REQ'D FRACTION OF MAX. POWER (PETF/PEHF AND LETF)

	PETF OR PEHF (NOTE *e*) LOC.	VALUE	LETF (NOTE *e*) LOC.	VALUE	Δt_H (HR) LOC.	VALUE	t_H (HR) LOC.	VALUE	$V_{R/C}$ (FT/MIN) LOC.	VALUE
1ST	0621		0641		0661		0681		2321	
2ND	0622		0642		0662		0682		2322	
3RD	0623		0643		0663		0683		2323	
4TH	0624		0644		0664		0684		2324	
5TH	0625		0645		0665		0685		2325	
6TH	0626		0646		0666		0686		2326	
7TH	0627		0647		0667		0687		2327	
8TH	0628		0648		0668		0688		2328	
9TH	0629		0649		0669		0689		2329	
10TH	0630		0650		0670		0690		2330	

NOTES:
a. DO NOT INPUT TOLIND = 2 IF LFTIND = 0
b. INPUT NOT NECESSARY WHEN ATMIND = 0,2
c. INPUT NOT NECESSARY WHEN TOLIND = 3
d. INPUT NOT NECESSARY WHEN N2IND = 0 1
e. INPUT NOT NECESSARY WHEN TOLIND = 1,2

NOTE: WHEN OPTIND = 2 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

FORM 49751 (5/80)

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

VASCOMP II V/STOL AIRCRAFT SIZING AND PERFORMANCE COMPUTER PROGRAM B-93

SHEET NO.	CASE NO.
OF	

NOTE: WHEN OPTIND = 2 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

CLIMB INFORMATION
SGTIND = 3

	CLMIND		ATMIND		ΔTin(°F) (NOTE *a*)		POWIND		$N_{II}/N_{II\,MAX}$ (NOTE *b*)		Δ n CLIMB (E-M CALCS)	
	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE
1ST	0691		0711		0731		0751		0771		0791	
2ND	0692		0712		0732		0752		0772		0792	
3RD	0693		0713		0733		0753		0773		0793	
4TH	0694		0714		0734		0754		0774		0794	
5TH	0695		0715		0735		0755		0775		0795	
6TH	0696		0716		0736		0756		0776		0796	
7TH	0697		0717		0737		0757		0777		0797	
8TH	0698		0718		0738		0758		0778		0798	
9TH	0699		0719		0739		0759		0779		0799	
10TH	0700		0720		0740		0760		0780		0800	

CLMIND: 1 = MAX R/C; 2 = CONSTANT EAS; 3 = CONSTANT MACH; 4 = CONSTANT TAS

ATMIND: 0 = STANDARD ATMOSPHERE; 1 = STD. + ΔTin; 2 = ARBITRARY θ(h)

POWIND: 0 = MAX POWER; 1 = MIL POWER; 2 = NORMAL POWER

(NOMINAL $\Delta n = 0$)

	MACH OR EAS OR TAS (KTS) (NOTE *c*)		Δh (FT)		h_{MAX}(FT)		θ_{MAX} (DEG)		ΔC_D CLIMB	
	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE
1ST	0701		0721		0741		0761		0781	
2ND	0702		0722		0742		0762		0782	
3RD	0703		0723		0743		0763		0783	
4TH	0704		0724		0744		0764		0784	
5TH	0705		0725		0745		0765		0785	
6TH	0706		0726		0746		0766		0786	
7TH	0707		0727		0747		0767		0787	
8TH	0708		0728		0748		0768		0788	
9TH	0709		0729		0749		0769		0789	
10TH	0710		0730		0750		0770		0790	

NOTES:

a. INPUT NOT NECESSARY WHEN ATMIND = 0,2

b. INPUT NOT NECESSARY WHEN N2IND = 0,1

c. INPUT NOT NECESSARY WHEN CLMIND = 1

FORM 49752 (5/80)

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

VASCOMP II V/STOL AIRCRAFT SIZING AND PERFORMANCE COMPUTER PROGRAM B-93

SHEET NO.	CASE
OF	

NOTE: WHEN OPTIND = 2 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

CRUISE INFORMATION
SGTIND = 4

	CRSIND		ATMIND		ΔTin (°F) (NOTE *a*)		POWIND (NOTE *b*)		$N_{II}/N_{II\ MAX.}$ (NOTE *c*)	
	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE
1ST	0801		0821		0841		0861		0881	
2ND	0802		0822		0842		0862		0882	
3RD	0803		0823		0843		0863		0883	
4TH	0804		0824		0844		0864		0884	
5TH	0805		0825		0845		0865		0885	
6TH	0806		0826		0846		0866		0886	
7TH	0807		0827		0847		0867		0887	
8TH	0808		0828		0848		0868		0888	
9TH	0809		0829		0849		0869		0889	
10TH	0810		0830		0850		0870		0890	

CRSIND:
1 = SPECIFIED POWER
2 = CONSTANT TAS
3 = BEST NMPP
4 = 99% BEST NMPP
5 = BEST NMPP, CONST. W/δ
6 = 99% BEST NMPP, CONST. W/δ

ATMIND:
0 = STANDARD ATMOSPHERE
1 = STD. + ΔTin
2 = ARBITRARY θ(h)

POWIND:
0 = MAX POWER
1 = MIL POWER
2 = NORMAL POWER

	V*in* or HEADWIND (NOTE *d*)		ΔR (NM)		R_{MAX} (NM)		$N_{PSD_{CR}}$		$\Delta C_{D_{CR}}$	
	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE
1ST	0811		0831		0851		0871		0891	
2ND	0812		0832		0852		0872		0892	
3RD	0813		0833		0853		0873		0893	
4TH	0814		0834		0854		0874		0894	
5TH	0815		0835		0855		0875		0895	
6TH	0816		0836		0856		0876		0896	
7TH	0817		0837		0857		0877		0897	
8TH	0818		0838		0858		0878		0898	
9TH	0819		0839		0859		0879		0899	
10TH	0820		0840		0860		0880		0900	

NOTES: INPUT NOT NECESSARY WHEN:
a. ATMIND = 0,2
b. CRSIND = 3
c. N2IND = 0,1
d. INPUT V*in* WHEN CRSIND = 2
INPUT HEADWIND WHEN CRSIND = 3 THRU 6

FORM 49753 (5/80)

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

VASCOMP II V/STOL AIRCRAFT SIZING AND PERFORMANCE COMPUTER PROGRAM B-93

SHEET NO.	CASE NO.
OF	

NOTE: WHEN OPTIND = 2 CONSIDER THOSE ITEMS IN THE SHADED BLOCKS

DESCENT INFORMATION

SGTIND = 5

	DESIND LOC.	DESIND VALUE	ATMIND LOC.	ATMIND VALUE	ΔT_{in} (°F) (NOTE *a*) LOC.	VALUE	R_{MAX} (NM) (NOTE *b*) LOC.	VALUE	$N_{II}/N_{II\,MAX}$ (NOTE *c*) LOC.	VALUE
1ST	0901		0921		0941		0961		0981	
2ND	0902		0922		0942		0962		0982	
3RD	0903		0923		0943		0963		0983	
4TH	0904		0924		0944		0964		0984	
5TH	0905		0925		0945		0965		0985	
6TH	0906		0926		0946		0966		0986	
7TH	0907		0927		0947		0967		0987	
8TH	0908		0928		0948		0968		0988	
9TH	0909		0929		0949		0969		0989	
10TH	0910		0930		0950		0970		0990	

DESIND:
1,2 = V MAX
3,4 = IDLE POWER
5,6 = CONSTANT EAS
7,8 = CONSTANT MACH
1,3,5,7 = TERMINAL RANGE SPECIFIED
2,4,6,8 = TERMINAL RANGE NOT SPECIFIED

ATMIND:
0 = STANDARD ATMOSPHERE
1 = STD. + ΔT_{in}
2 = ARBITRARY θ(h)

	MACH OR EAS (KTS) (NOTE *d*) LOC.	VALUE	θ_{MIN} (DEG) LOC.	VALUE	Δh (FT) LOC.	VALUE	h_{MIN} (FT) LOC.	VALUE	$\Delta C_{D\ DESC.}$ LOC.	VALUE
1ST	0911		0931		0951		0971		0991	
2ND	0912		0932		0952		0972		0992	
3RD	0913		0933		0953		0973		0993	
4TH	0914		0934		0954		0974		0994	
5TH	0915		0935		0955		0975		0995	
6TH	0916		0936		0956		0976		0996	
7TH	0917		0937		0957		0977		0997	
8TH	0918		0938		0958		0978		0998	
9TH	0919		0939		0959		0979		0999	
10TH	0920		0940		0960		0980		1000	

NOTES: INPUT NOT NECESSARY WHEN:
a. ATMIND = 0,2
b. DESIND = 2,4,6,8
c. N2IND = 0,1
d. DESIND = 1,2,3,4

FORM 49754 (5/60)

BOEING VERTOL COMPANY
DIVISION OF THE BOEING COMPANY

VASCOMP II V/STOL AIRCRAFT SIZING AND PERFORMANCE COMPUTER PROGRAM B-93

SHEET NO.	CASE NO.
OF	

LOITER INFORMATION

NOTE: WHEN OPTIND = 2 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

SGTIND = 6

	LTRIND LOC.	LTRIND VALUE	ATMIND LOC.	ATMIND VALUE	ΔTin (°F) (NOTE *a*) LOC.	ΔTin (°F) VALUE	$N_{II}/N_{II\,MAX}$ (NOTE *b*) LOC.	$N_{II}/N_{II\,MAX}$ VALUE
1ST	1001		1021		1041		1061	
2ND	1002		1022		1042		1062	
3RD	1003		1023		1043		1063	
4TH	1004		1024		1044		1064	
5TH	1005		1025		1045		1065	
6TH	1006		1026		1046		1066	
7TH	1007		1027		1047		1067	
8TH	1008		1028		1048		1068	
9TH	1009		1029		1049		1069	
10TH	1010		1030		1050		1070	

LTRIND: 1 = FUEL REQUIRED FOR MISSION; 2 = RESERVE FUEL CALCULATION

ATMIND: 0 = STANDARD ATMOSPHERE; 1 = STD. + ΔTin; 2 = ARBITRARY $\theta(h)$

	Δt_L (HR) LOC.	Δt_L (HR) VALUE	t_L (HR) LOC.	t_L (HR) VALUE	$N_{PSD_{LOITER}}$ LOC.	$N_{PSD_{LOITER}}$ VALUE	$\Delta C_{D_{LOITER}}$ LOC.	$\Delta C_{D_{LOITER}}$ VALUE	$\left[(W/S)_{WING+FLAP} / (W/S)_{WING}\right]$ LOC	VALUE
1ST	1011		1031		1051		1071		1081	
2ND	1012		1032		1052		1072		1082	
3RD	1013		1033		1053		1073		1083	
4TH	1014		1034		1054		1074		1084	
5TH	1015		1035		1055		1075		1085	
6TH	1016		1036		1056		1076		1086	
7TH	1017		1037		1057		1077		1087	
8TH	1018		1038		1058		1078		1088	
9TH	1019		1039		1059		1079		1089	
10TH	1020		1040		1060		1080		1090	

NOTE: *a*. INPUT NOT NECESSARY WHEN ATMIND = 0,2 *b*. INPUT NOT NECESSARY WHEN N2IND = 0,1

FORM 49755 (5/80)

SHEET NO.	CASE NO.
OF	

CHANGE IN FUEL WEIGHT

SGTIND = 7

ΔW_f (LBS)

	LOC.	VALUE
1ST	1101	
2ND	1102	
3RD	1103	
4TH	1104	
5TH	1105	
6TH	1106	
7TH	1107	
8TH	1108	
9TH	1109	
10TH	1110	

t_{FW} (HR)

LOC.	VALUE
1121	
1122	
1123	
1124	
1125	
1126	
1127	
1128	
1129	
1130	

CHANGE IN PAYLOAD WEIGHT

SGTIND = 8

ΔW_{PL} (LBS)

LOC.	VALUE
1131	
1132	
1133	
1134	
1135	
1136	
1137	
1138	
1139	
1140	

t_{PW} (HR)

LOC.	VALUE
1141	
1142	
1143	
1144	
1145	
1146	
1147	
1148	
1149	
1150	

TRANSFER ALTITUDE; SGTIND = 9

h_{FINAL} (FT.) (h_{OPT} IND = 0)
OR h_{MAX} (FT.) (h_{OPT} IND = 1)

	LOC.	VALUE
1ST	1111	
2ND	1112	
3RD	1113	
4TH	1114	
5TH	1115	
6TH	1116	
7TH	1117	
8TH	1118	
9TH	1119	
10TH	1120	

CHANGE FUEL OR CHANGE PAYLOAD

SGTIND = 7
OR SGTIND = 8

WGTIND

LOC	VALUE
1151	

$0 = W + \Delta W \leq W_G$

1 = NO WEIGHT RESTRICTION

NOTE: WHEN OPTIND = 2 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

FORM 49756 (5/80)

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

VASCOMP II V/STOL AIRCRAFT SIZING AND PERFORMANCE COMPUTER PROGRAM B-93

SHEET NO. OF | CASE NO.

GENERAL PERFORMANCE INFORMATION (SGTIND = 11)

	GWIND		ATMIND		ΔT_{IN}(°F) (Note a)		ALTITUDE (FT)		N_{II}/N_{II} MAX TAKEOFF		V_{MAX} (KTS)	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
1st	2201		2221		2241		2261		2281		2301	
2nd	2202		2222		2242		2262		2282		2302	
3rd	2203		2223		2243		2263		2283		2303	
4th	2204		2224		2244		2264		2284		2304	
5th	2205		2225		2245		2265		2285		2305	
6th	2206		2226		2246		2266		2286		2306	
7th	2207		2227		2247		2267		2287		2307	
8th	2208		2228		2248		2268		2288		2308	
9th	2209		2229		2249		2269		2289		2309	
10th	2210		2230		2250		2270		2290		2310	

GWIND: 1 = ΔGW INPUT; 2 = GW INPUT

ATMIND: 0 = STANDARD ATMOSPHERE; 1 = STD + ΔT_{IN}; 2 = ARBITRARY $\theta_{(h)}$

WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

	GW OR ΔGW(LB) (Note b)		$C_{L_{WING}}$		$\Delta C_{D_{CR}}$(FT2)		T/W		ΔV (KTS)		N_{II}/N_{II} MAX CRUISE	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
1st	2211		2231		2251		2271		2291		2311	
2nd	2212		2232		2252		2272		2292		2312	
3rd	2213		2233		2253		2273		2293		2313	
4th	2214		2234		2254		2274		2294		2314	
5th	2215		2235		2255		2275		2295		2315	
6th	2216		2236		2256		2276		2296		2316	
7th	2217		2237		2257		2277		2297		2317	
8th	2218		2238		2258		2278		2298		2318	
9th	2219		2239		2259		2279		2299		2319	
10th	2220		2240		2260		2280		2300		2320	

NOTES: a. INPUT NOT NECESSARY WHEN ATMIND = 0, 2

b. INPUT ΔGW WHEN GWIND = 1
INPUT GW WHEN GWIND = 2

FORM 49749 (6/80)

SHEET NO.	CASE NO.
OF	

ENGINE CYCLE DATA; NON-STANDARD PERFORMANCE

PRIMARY ENGINE DATA

VARIABLE	LOC	VALUE
WDTIND	1201	
N1IND	1202	
N1θIND	1203	
N2IND	1204	
QIND	1205	

VARIABLE	LOC	VALUE	
$\dot{W}_{MAX}/\dot{W}^*$	1220		INPUT IF WDTIND = 1
$N_{I_{MAX}}/N_I^*$	1221		INPUT IF N1IND = 1
$(N_I/\sqrt{\theta_1}/N_I^*)_{MAX}$	1222		INPUT IF N1θIND = 1
$N_{II_{MAX}}/N_{II}^*$	1223		INPUT IF N2IND = 1,2
Q_{MAX}/Q^*	1224		INPUT IF QIND = 1

WDTIND: {0 = NO FUEL FLOW CUTOFF; 1 = FUEL FLOW CUTOFF

N1IND: {0 = NO N1 CUTOFF; 1 = N1 CUTOFF

N2IND: {0 = NO N2 CUTOFF; OPTIMUM N2 VARIATION; 1 = N2 CUTOFF; OPTIMUM N2 VARIATION; 2 = N2 CUTOFF; NON-OPTIMUM N2 VARIATION

QIND: {0 = NO TORQUE CUTOFF; 1 = TORQUE CUTOFF

N1θIND: {0 = NO REFERRED N1 CUTOFF; 1 = REFERRED N1 CUTOFF

NOTE: WHEN OPTIND = 2 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

VARIABLE	LOC	VALUE
RNOIND	1206	

0 = NO REYNOLDS NO. CORRECTIONS
1 = REYNOLDS NO. CORRECTIONS

REYNOLDS NO. CORRECTION FACTOR

VALUES OF $\frac{N_I}{N_I^*}\frac{D}{\nu_1}$

LOC	VALUE
1207	
1208	
1209	
1210	
1211	
1212	
1213	
1214	
1215	
1216	

VALUES OF K_{PR}

LOC	VALUE
1225	
1226	
1227	
1228	
1229	
1230	
1231	
1232	
1233	
1234	

INPUT THIS TABLE IF RNOIND = 1

OUTPUT SHAFT SPEED CORRECTION

VALUES OF $\frac{N_{II}}{N_{II_{OPT}}}$

LOC	VALUE
1238	
1239	
1240	
1241	
1242	
1243	
1244	
1245	
1246	
1247	

VALUES OF K_{PN}

LOC	VALUE
1248	
1249	
1250	
1251	
1252	
1253	
1254	
1255	
1256	
1257	

INPUT THIS TABLE IF N2IND = 2 AND NON-STANDARD CORRECTION IS DESIRED

LIFT ENGINE DATA

VARIABLE	LOC	VALUE
LWDIND	1217	
LN1IND	1218	
LN2IND	1219	

VARIABLE	LOC	VALUE	
$(\dot{W}_{MAX}/\dot{W}^*)_L$	1235		INPUT IF LWDIND = 1
$(N_{I_{MAX}}/N_I^*)_L$	1236		INPUT IF LN1IND = 1
$(N_{II_{MAX}}/N_{II}^*)_L$	1237		INPUT IF LN2IND = 1

LWDIND: {0 = NO FUEL FLOW CUTOFF; 1 = FUEL FLOW CUTOFF

LN2IND: {0 = NO N2 CUTOFF; 1 = N2 CUTOFF

LN1IND: {0 = NO N1 CUTOFF; 2 = N1 CUTOFF

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

VASCOMP II V/STOL AIRCRAFT SIZING AND PERFORMANCE COMPUTER PROGRAM B-93

SHEET NO. OF	CASE NO.

PRIMARY ENGINE CYCLE INFORMATION (Sheet 1)

THESE TABLES NOT REQUIRED WHEN STANDARD CYCLE IS SELECTED.

VARIABLE	LOC	VALUE
CYCLE NO.	1301	
k_3	1302	
k_4	1303	

} NOTE *a*.

VARIABLE	LOC	VALUE
ξ_4	1304	
T_{GI} (°R)	1305	
T_{FI} (°R)	1306	

NOTE *b*.

VARIABLE	LOC	VALUE
T_{IP} (°R)	1307	
T_{MIL} (°R)	1308	
T_{MAX} (°R)	1309	

ALL TABLES MUST BE AT LEAST 3 x 3 IN SIZE

NO. OF T/θ	LOC 1310	VALUE
VALUES OF T/θ		
	LOC	VALUE
1	1311	
2	1312	
3	1313	
4	1314	
5	1315	
6	1316	
7	1317	
8	1318	

NO. OF M	LOC 1319	VALUE
VALUES OF M		
	LOC	VALUE
M_1	1320	
M_2	1321	
M_3	1322	
M_4	1323	
M_5	1324	
M_6	1325	

VALUES OF REFERRED THRUST OR HORSEPOWER $(F_N/\delta F_N{}^*$ OR $SHP/SHP^*\,\delta\sqrt{\theta})$

	$(T/\theta)_1=$		$(T/\theta)_2=$		$(T/\theta)_3=$		$(T/\theta)_4=$		$(T/\theta)_5=$		$(T/\theta)_6=$		$(T/\theta)_7=$		$(T/\theta)_8=$	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
M_1	1326		1332		1338		1344		1350		1356		1362		1368	
M_2	1327		1333		1339		1345		1351		1357		1363		1369	
M_3	1328		1334		1340		1346		1352		1358		1364		1370	
M_4	1329		1335		1341		1347		1353		1359		1365		1371	
M_5	1330		1336		1342		1348		1354		1360		1366		1372	
M_6	1331		1337		1343		1349		1355		1361		1367		1373	

NOTE: WHEN OPTIND = 2 CONSIDER THOSE ITEMS IN THE SHADED BLOCKS

NO. OF T/θ	LOC 1374	VALUE
VALUES OF T/θ		
	LOC	VALUE
1	1375	
2	1376	
3	1377	
4	1378	
5	1379	
6	1380	
7	1381	
8	1382	

NO. OF M	LOC 1383	VALUE
VALUES OF M		
	LOC	VALUE
M_1	1384	
M_2	1385	
M_3	1386	
M_4	1387	
M_5	1388	
M_6	1389	

VALUES OF REFERRED FUEL FLOW $(\dot{\omega}_f/\delta\sqrt{\theta}F_N^*$ OR $\dot{\omega}_f/\delta\sqrt{\theta}\,SHP^*)$

	$(T/\theta)_1=$		$(T/\theta)_2=$		$(T/\theta)_3=$		$(T/\theta)_4=$		$(T/\theta)_5=$		$(T/\theta)_6=$		$(T/\theta)_7=$		$(T/\theta)_8=$	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
M_1	1390		1396		1402		1408		1414		1420		1426		1432	
M_2	1391		1397		1403		1409		1415		1421		1427		1433	
M_3	1392		1398		1404		1410		1416		1422		1428		1434	
M_4	1393		1399		1405		1411		1417		1423		1429		1435	
M_5	1394		1400		1406		1412		1418		1424		1430		1436	
M_6	1395		1401		1407		1413		1419		1425		1431		1437	

NOTE *a*. k_4 IN LBS; IF ENGIND = 0, k_3 IS IN LB/HP; IF ENGIND = 1,2, k_3 IS IN LB/LB THRUST

b. IF ENGIND = 0, ξ_4 IS IN FT/SHP$^{\frac{1}{2}}$; IF ENGIND = 1,2, ξ_4 IS IN FT/LB THRUST$^{\frac{1}{2}}$

FORM 49761 (5/80)

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

VASCOMP II V/STOL AIRCRAFT SIZING AND PERFORMANCE COMPUTER PROGRAM B-93

SHEET NO. OF	CASE NO.

PRIMARY ENGINE CYCLE INFORMATION (Sheet 2)

NO. OF T/θ	LOC	VALUE
	1438	

NO. OF M	LOC	VALUE
	1447	

VALUES OF T/θ

	LOC	VALUE
1	1439	
2	1440	
3	1441	
4	1442	
5	1443	
6	1444	
7	1445	
8	1446	

VALUES OF M

	LOC	VALUE
M_1	1448	
M_2	1449	
M_3	1450	
M_4	1451	
M_5	1452	
M_6	1453	

VALUES OF REFERRED N_I ($N_I/\sqrt{\theta}N_I^*$)

	$(T/\theta)_1=$		$(T/\theta)_2=$		$(T/\theta)_3=$		$(T/\theta)_4=$		$(T/\theta)_5=$		$(T/\theta)_6=$		$(T/\theta)_7=$		$(T/\theta)_8=$	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
M_1	1454		1460		1466		1472		1478		1484		1490		1496	
M_2	1455		1461		1467		1473		1479		1485		1491		1497	
M_3	1456		1462		1468		1474		1480		1486		1492		1498	
M_4	1457		1463		1469		1475		1481		1487		1493		1499	
M_5	1458		1464		1470		1476		1482		1488		1494		1500	
M_6	1459		1465		1471		1477		1483		1489		1495		1501	

NOTE: WHEN OPTIND = 2 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

NO. OF T/θ	LOC	VALUE
	1502	

NO. OF M	LOC	VALUE
	1511	

VALUES OF T/θ

	LOC	VALUE
1	1503	
2	1504	
3	1505	
4	1506	
5	1507	
6	1508	
7	1509	
8	1510	

VALUES OF M

	LOC	VALUE
M_1	1512	
M_2	1513	
M_3	1514	
M_4	1515	
M_5	1516	
M_6	1517	

VALUES OF REFERRED N_{II} ($N_{II}/\sqrt{\theta}N_{II}^*$)

	$(T/\theta)_1=$		$(T/\theta)_2=$		$(T/\theta)_3=$		$(T/\theta)_4=$		$(T/\theta)_5=$		$(T/\theta)_6=$		$(T/\theta)_7=$		$(T/\theta)_8=$	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
M_1	1518		1524		1530		1536		1542		1548		1554		1560	
M_2	1519		1525		1531		1537		1543		1549		1555		1561	
M_3	1520		1526		1532		1538		1544		1550		1556		1562	
M_4	1521		1527		1533		1539		1545		1551		1557		1563	
M_5	1522		1528		1534		1540		1546		1552		1558		1564	
M_6	1523		1529		1535		1541		1547		1553		1559		1565	

FORM 49762 (5/80)

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

VASCOMP II V/STOL AIRCRAFT SIZING AND PERFORMANCE COMPUTER PROGRAM B-93

SHEET NO. of	CASE NO.

LIFT ENGINE CYCLE INFORMATION

(NOT REQUIRED WHEN STANDARD CYCLE)
(IS SELECTED OR WHEN LFTIND = 0)

NOTE: WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

VAR	LOC	VALUE
CYCLE NO.	1601	
k_1	1602	
k_2	1603	

NOTE a.

NOTE b.

VAR	LOC	VALUE
ξ_1	1604	
ξ_2	1605	
ξ_3	1606	

VAR	LOC	VALUE
T_{GI}	1607	
T_{MAX}	1608	

NOTE a: k_2 IN LBS.; k_1 IN LB/LB THRUST

NOTE b: ξ_2 IN FT , ξ_1, ξ_3 IN FT/LB THRUST $^{\frac{1}{2}}$

REFERRED THRUST AS A FUNCTION OF T/θ

VARIABLE	LOC	VALUE
$(T/\theta)_1$	1609	
$(T/\theta)_2$	1610	
$(T/\theta)_3$	1611	
$(T/\theta)_4$	1612	
$(T/\theta)_5$	1613	
$(T/\theta)_6$	1614	
$(T/\theta)_7$	1615	
$(T/\theta)_8$	1616	

VARIABLE	LOC	VALUE
$(F_N/\delta F_{NL}^*)_1$	1617	
$(F_N/\delta F_{NL}^*)_2$	1618	
$(F_N/\delta F_{NL}^*)_3$	1619	
$(F_N/\delta F_{NL}^*)_4$	1620	
$(F_N/\delta F_{NL}^*)_5$	1621	
$(F_N/\delta F_{NL}^*)_6$	1622	
$(F_N/\delta F_{NL}^*)_7$	1623	
$(F_N/\delta F_{NL}^*)_8$	1624	

REFERRED N_I AS A FUNCTION OF T/θ

VARIABLE	LOC	VALUE
$(T/\theta)_1$	1641	
$(T/\theta)_2$	1642	
$(T/\theta)_3$	1643	
$(T/\theta)_4$	1644	
$(T/\theta)_5$	1645	
$(T/\theta)_6$	1646	
$(T/\theta)_7$	1647	
$(T/\theta)_8$	1648	

VARIABLE	LOC	VALUE
$(N_I/N_{IL}^*\sqrt{\theta})_1$	1649	
$(N_I/N_{IL}^*\sqrt{\theta})_2$	1650	
$(N_I/N_{IL}^*\sqrt{\theta})_3$	1651	
$(N_I/N_{IL}^*\sqrt{\theta})_4$	1652	
$(N_I/N_{IL}^*\sqrt{\theta})_5$	1653	
$(N_I/N_{IL}^*\sqrt{\theta})_6$	1654	
$(N_I/N_{IL}^*\sqrt{\theta})_7$	1655	
$(N_I/N_{IL}^*\sqrt{\theta})_8$	1656	

REFERRED FUEL FLOW AS A FUNCTION OF T/θ

VARIABLE	LOC	VALUE
$(T/\theta)_1$	1625	
$(T/\theta)_2$	1626	
$(T/\theta)_3$	1627	
$(T/\theta)_4$	1628	
$(T/\theta)_5$	1629	
$(T/\theta)_6$	1630	
$(T/\theta)_7$	1631	
$(T/\theta)_8$	1632	

VARIABLE	LOC	VALUE
$(\dot{W}_f/\delta\sqrt{\theta}F_{NL}^*)_1$	1633	
$(\dot{W}_f/\delta\sqrt{\theta}F_{NL}^*)_2$	1634	
$(\dot{W}_f/\delta\sqrt{\theta}F_{NL}^*)_3$	1635	
$(\dot{W}_f/\delta\sqrt{\theta}F_{NL}^*)_4$	1636	
$(\dot{W}_f/\delta\sqrt{\theta}F_{NL}^*)_5$	1637	
$(\dot{W}_f/\delta\sqrt{\theta}F_{NL}^*)_6$	1638	
$(\dot{W}_f/\delta\sqrt{\theta}F_{NL}^*)_7$	1639	
$(\dot{W}_f/\delta\sqrt{\theta}F_{NL}^*)_8$	1640	

REFERRED N_{II} AS A FUNCTION OF T/θ

VARIABLE	LOC	VALUE
$(T/\theta)_1$	1657	
$(T/\theta)_2$	1658	
$(T/\theta)_3$	1659	
$(T/\theta)_4$	1660	
$(T/\theta)_5$	1661	
$(T/\theta)_6$	1662	
$(T/\theta)_7$	1663	
$(T/\theta)_8$	1664	

VARIABLE	LOC	VALUE
$(N_{II}/N_{IIL}^*\sqrt{\theta})_1$	1665	
$(N_{II}/N_{IIL}^*\sqrt{\theta})_2$	1666	
$(N_{II}/N_{IIL}^*\sqrt{\theta})_3$	1667	
$(N_{II}/N_{IIL}^*\sqrt{\theta})_4$	1668	
$(N_{II}/N_{IIL}^*\sqrt{\theta})_5$	1669	
$(N_{II}/N_{IIL}^*\sqrt{\theta})_6$	1670	
$(N_{II}/N_{IIL}^*\sqrt{\theta})_7$	1671	
$(N_{II}/N_{IIL}^*\sqrt{\theta})_8$	1672	

FORM 49763 (5/80)

HOVER PERFORMANCE MAP

TABLE NO. ______________

	LOC	VALUE
NO. OF C_T/σ'S	2351	

	LOC	VALUE
NO. OF M_{TIP}'S	2362	

VALUES OF C_T/σ

	LOC	VALUE
$(C_T/\sigma)_1$	2352	
$(C_T/\sigma)_2$	2353	
$(C_T/\sigma)_3$	2354	
$(C_T/\sigma)_4$	2355	
$(C_T/\sigma)_5$	2356	
$(C_T/\sigma)_6$	2357	
$(C_T/\sigma)_7$	2358	
$(C_T/\sigma)_8$	2359	
$(C_T/\sigma)_9$	2360	
$(C_T/\sigma)_{10}$	2361	

VALUES OF M_{TIP}

	LOC	VALUE
M_{T_1}	2363	
M_{T_2}	2364	
M_{T_3}	2365	
M_{T_4}	2366	
M_{T_5}	2367	
M_{T_6}	2368	

C_T/σ = THRUST $\pi^2 / \rho V_{TIP}^2 D^3 \sigma$

INPUT VALUES OF FIGURE OF MERIT
FOR COMBINATIONS OF
C_T/σ and M_{TIP}

	M_{TIP_1}=		M_{TIP_2}=		M_{TIP_3}=		M_{TIP_4}=		M_{TIP_5}=		M_{TIP_6}=	
	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE	LOC	VALUE
$(C_T/\sigma)_1$ =	2369		2379		2389		2399		2409		2419	
$(C_T/\sigma)_2$ =	2370		2380		2390		2400		2410		2420	
$(C_T/\sigma)_3$ =	2371		2381		2391		2401		2411		2421	
$(C_T/\sigma)_4$ =	2372		2382		2392		2402		2412		2422	
$(C_T/\sigma)_5$ =	2373		2383		2393		2403		2413		2423	
$(C_T/\sigma)_6$ =	2374		2384		2394		2404		2414		2424	
$(C_T/\sigma)_7$ =	2375		2385		2395		2405		2515		2425	
$(C_T/\sigma)_8$ =	2376		2386		2396		2406		2516		2426	
$(C_T/\sigma)_9$ =	2377		2387		2397		2407		2517		2427	
$(C_T/\sigma)_{10}$ =	2378		2388		2398		2408		2518		2428	

NOTES: a. WHEN OPTIND = 2 OR 3 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS
b. C_T IS IN PROPELLER ROTATION
c. INPUT AT LEAST 3 VALUES OF C_T/σ AND M_{TIP}

SHEET NO.	CASE NO.
OF	

PROPELLER/FAN PERFORMANCE DATA (Sheet 1 of 3)

THIS SHEET IS REQUIRED WHEN η_pIND = 1 OR 3

NOTE: AT LEAST 3 VALUES OF J OR M AND 3 VALUES OF C_T OR $F_N/A_2\delta$ MUST BE USED

	LOC.	VALUE
PROP/FAN TABLE NO.	1700	

NOTE: WHEN OPTIND = 2 CONSIDER THOSE ITEMS IN THE SHADED BLOCKS

	LOC.	VALUE
NO. OF ADVANCE RATIOS (J) OR MACH NUMBER (M)	1701	

	LOC.	VALUE
NO. OF PROP THRUST COEFFICIENTS (C_T) OR REFERRED THRUST ($F_N/A_2\delta$)	1722	

VALUES OF J OR MACH NO.

	LOC.	VALUE
J_1 or M_1	1702	
J_2 or M_2	1703	
J_3 or M_3	1704	
J_4 or M_4	1705	
J_5 or M_5	1706	
J_6 or M_6	1707	
J_7 or M_7	1708	
J_8 or M_8	1709	
J_9 or M_9	1710	
J_{10} or M_{10}	1711	
J_{11} or M_{11}	1712	
J_{12} or M_{12}	1713	
J_{13} or M_{13}	1714	
J_{14} or M_{14}	1715	
J_{15} or M_{15}	1716	
J_{16} or M_{16}	1717	
J_{17} or M_{17}	1718	
J_{18} or M_{18}	1719	
J_{19} or M_{19}	1720	
J_{20} or M_{20}	1721	

VALUES OF C_T OR $F_{N_{REF}}$

	LOC.	VALUE
G_1 or FN_1	1723	
G_2 or FN_2	1724	
G_3 or FN_3	1725	
G_4 or FN_4	1726	
G_5 or FN_5	1727	
G_6 or FN_6	1728	
G_7 or FN_7	1729	
G_8 or FN_8	1730	
G_9 or FN_9	1731	
G_{10} or FN_{10}	1732	
G_{11} or FN_{11}	1733	
G_{12} or FN_{12}	1734	
G_{13} or FN_{13}	1735	
G_{14} or FN_{14}	1736	
G_{15} or FN_{15}	1737	
G_{16} or FN_{16}	1738	
G_{17} or FN_{17}	1739	
G_{18} or FN_{18}	1740	
G_{19} or FN_{19}	1741	
G_{20} or FN_{20}	1742	

NOTE: A_2 IS THE ANNULUS AREA OF THE FAN

FORM 49765 (5/80)

BOEING VERTOL COMPANY **VASCOMP II** V/STOL AIRCRAFT SIZING AND PERFORMANCE COMPUTER PROGRAM B-93
A DIVISION OF THE BOEING COMPANY

SHEET NO.	CASE NO.
OF	

PROPELLER/FAN PERFORMANCE DATA (Sheet 2 of 3)

NOTE: WHEN OPTIND = 2 CONSIDER THOSE ITEMS IN THE SHADED BLOCKS

THIS SHEET IS REQUIRED WHEN η_pIND = 1 OR 3

INPUT VALUES OF PROP OR FAN POWER COEFFICIENT FOR COMBINATIONS OF J OR M AND C_T OR $F_{N_{REF}}$

ADVANCE RATIO OR MACH NO.	PROPELLER OR FAN THRUST COEFFICIENT																			
	C_{T1}/ F_{N1} =		C_{T2}/ F_{N2} =		C_{T3}/ F_{N3} =		C_{T4}/ F_{N4} =		C_{T5}/ F_{N5} =		C_{T6}/ F_{N6} =		C_{T7}/ F_{N7} =		C_{T8}/ F_{N8} =		C_{T9}/ F_{N9} =		C_{T10}/ F_{N10} =	
	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE
J_1/M_1 =	1743		1763		1783		1803		1823		1843		1863		1883		1903		1923	
J_2/M_2 =	1744		1764		1784		1804		1824		1844		1864		1884		1904		1924	
J_3/M_3 =	1745		1765		1785		1805		1825		1845		1865		1885		1905		1925	
J_4/M_4 =	1746		1766		1786		1806		1826		1846		1866		1886		1906		1926	
J_5/M_5 =	1747		1767		1787		1807		1827		1847		1867		1887		1907		1927	
J_6/M_6 =	1748		1768		1788		1808		1828		1848		1868		1888		1908		1928	
J_7/M_- =	1749		1769		1789		1809		1829		1849		1869		1889		1909		1929	
J_8/M_8 =	1750		1770		1790		1810		1830		1850		1870		1890		1910		1930	
J_9/M_9 =	1751		1771		1791		1811		1831		1851		1871		1891		1911		1931	
J_{10}/M_{10} =	1752		1772		1792		1812		1832		1852		1872		1892		1912		1932	
J_{11}/M_{11} =	1753		1773		1793		1813		1833		1853		1873		1893		1913		1933	
J_{12}/M_{12} =	1754		1774		1794		1814		1834		1854		1874		1894		1914		1934	
J_{13}/M_{13} =	1755		1775		1795		1815		1835		1855		1875		1895		1915		1935	
J_{14}/M_{14} =	1756		1776		1796		1816		1836		1856		1876		1896		1916		1936	
J_{15}/M_{15} =	1757		1777		1797		1817		1837		1857		1877		1897		1917		1937	
J_{16}/M_{16} =	1758		1778		1798		1818		1838		1858		1878		1898		1918		1938	
J_{17}/M_{17} =	1759		1779		1799		1819		1839		1859		1879		1899		1919		1939	
J_{18}/M_{18} =	1760		1780		1800		1820		1840		1860		1880		1900		1920		1940	
J_{19}/M_{19} =	1761		1781		1801		1821		1841		1861		1881		1901		1921		1941	
J_{20}/M_{20} =	1762		1782		1802		1822		1842		1862		1882		1902		1922		1942	

NOTE: 1. IF MORE THAN 10 VALUES OF C_T OR F_N ARE REQUIRED, USE SHEET 3 FOR CONTINUATION OF TABLE.

FORM 49766 (5/80)

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

VASCOMP II V/STOL AIRCRAFT SIZING AND PERFORMANCE COMPUTER PROGRAM B-93

SHEET NO.	CA NO.
OF	

PROPELLER/FAN PERFORMANCE DATA (Sheet 3 of 3)

NOTE: WHEN OPTIND = 2 CONSIDER ONLY THOSE ITEMS IN THE SHADED BLOCKS

THIS SHEET IS REQUIRED WHEN η_pIND = 1 OR 3

INPUT VALUES OF PROP OR FAN POWER COEFFICIENT FOR COMBINATIONS OF J OR M AND C_T OR $F_{N_{REF}}$

PROPELLER OR FAN THRUST COEFFICIENT

ADVANCE RATIO OR MACH NO.	$C_{T_{11}}/M_{11}$ =		$C_{T_{12}}/M_{12}$ =		$C_{T_{13}}/M_{13}$ =		$C_{T_{14}}/M_{14}$ =		$C_{T_{15}}/M_{15}$ =		$C_{T_{16}}/M_{16}$ =		$C_{T_{17}}/M_{17}$ =		$C_{T_{18}}/M_{18}$ =		$C_{T_{19}}/M_{19}$ =		$C_{T_{20}}/M_{20}$ =	
	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE	LOC.	VALUE
J_1/M_1 =	1943		1963		1983		2003		2023		2043		2063		2083		2103		2123	
J_2/M_2 =	1944		1964		1984		2004		2024		2044		2064		2084		2104		2124	
J_3/M_3 =	1945		1965		1985		2005		2025		2045		2065		2085		2105		2125	
J_4/M_4 =	1946		1966		1986		2006		2026		2046		2066		2086		2106		2126	
J_5/M_5 =	1947		1967		1987		2007		2027		2047		2067		2087		2107		2127	
J_6/M_6 =	1948		1968		1988		2008		2028		2048		2068		2088		2108		2128	
J_7/M_7 =	1949		1969		1989		2009		2029		2049		2069		2089		2109		2129	
J_8/M_8 =	1950		1970		1990		2010		2030		2050		2070		2090		2110		2130	
J_9/M_9 =	1951		1971		1991		2011		2031		2051		2071		2091		2111		2131	
J_{10}/M_{10} =	1952		1972		1992		2012		2032		2052		2072		2092		2112		2132	
J_{11}/M_{11} =	1953		1973		1993		2013		2033		2053		2073		2093		2113		2133	
J_{12}/M_{12} =	1954		1974		1994		2014		2034		2054		2074		2094		2114		2134	
J_{13}/M_{13} =	1955		1975		1995		2015		2035		2055		2075		2095		2115		2135	
J_{14}/M_{14} =	1956		1976		1996		2016		2036		2056		2076		2096		2116		2136	
J_{15}/M_{15} =	1957		1977		1997		2017		2037		2057		2077		2097		2117		2137	
J_{16}/M_{16} =	1958		1978		1998		2018		2038		2058		2078		2098		2118		2138	
J_{17}/M_{17} =	1959		1979		1999		2019		2039		2059		2079		2099		2119		2139	
J_{18}/M_{18} =	1960		1980		2000		2020		2040		2060		2080		2100		2120		2140	
J_{19}/M_{19} =	1961		1981		2001		2021		2041		2061		2081		2101		2121		2141	
J_{20}/M_{20} =	1962		1982		2002		2022		2042		2062		2082		2102		2122		2142	

FORM 49767 (5/80)

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY

VASCOMP V/STOL AIRCRAFT SIZING AND PERFORMANCE COMPUTER PROGRAM B-93

SHEET NO.	CASE NO.
OF	

SUPPLEMENTARY INPUT

VARIABLE	LOC	VALUE	VARIABLE	LOC	VALUE	VARIABLE	LOC	VALUE

FORM 48410 (11/76)

5.3.1 PROGRAM VARIABLES

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
AF	0228	AF	Activity factor (per blade) of propeller
AR	0101	DAM2	Wing aspect ratio
AR_{HT}	0109	ARHT	Horizontal tail aspect ratio
Aisle Width (IN)	0158	WAISL1	Width of the aisles in first class
Aisle Width (IN)	0166	WAISLT	Width of the aisle in tourist class
AR_{VT}	0129	ARVT	Vertical tail aspect ratio
a_H	0110	SAH	Height of horizontal tail above top of local fuselage (fraction of vertical tail span)
$\overline{C/D}$	0103	DAM3	Mean wing chord to propeller diameter ratio
C_{DHTi}	0302	CDHTI	Profile drag coefficient of lift engine nacelles at $R_e = 10^7$ (based on total wetted area of nacelle clusters)
C_{DLNi}	0304	CDLNI	Profile drag coefficient of horizontal tail at $R_e = 10^7$ (based on horizontal tail planform area)
C_{DNi}	0303	CDNI	Profile drag coefficient of primary engine nacelles at $R_e = 10^7$ (based on wetted area of all nacelles)
C_{DVTi}	0301	CDVTI	Profile drag coefficient of vertical tail at $R_e = 10^7$ (based on vertical tail planform area)
C_{DWi}	0335-0342	TBCDWI	Profile drag coefficient of wing at $R_e = 10^7$ (based on wing planform area)

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
ΔC_D	0305	DELCD	Profile drag increment (based on wing planform area)
ΔC_{DCLIMB}	0781-0790	DCLIMB	Profile drag increase during climb.
ΔC_{DCR}	0891-0900	DLCDCR	Profile drag increase during cruise due to engines being shut down (based on wing planform area)
ΔC_{DDESC}	0991-1000	CLCDDS	Profile drag increase during descent. Used to simulate drag brakes.
ΔC_{DDM}	0350-0384	TBCDM	Increase in airplane drag due to Mach number (compressibility effects). Input table as a function of Mach number and lift coefficient (based on wing planform area)
$\Delta C_{DLOITER}$	1071-1080	DLOITR	Increase in planform drag during loiter
C_{Li}	0230	CLEYE	Propeller integrated design lift coefficient
$C_{\ell\alpha}$	0331	CSALF	Two-dimensional lift coefficient slope (Rad.$^{-1}$)
C_i	0317-0324	TBCL1	Values of lift coefficients
C_L	0343-0349	TBCL2	Values of lift coefficients
C_p	1723-1742	CPPROP	Propeller power coefficient (550 HP/$\rho\eta^e D^5$)
C_T	1743-2142	CTPROP	Propeller thrust coefficient (Thrust/$\rho\eta^2 D^4$)
C_T/σ	0227	CTSIG	Ratio of thrust coefficient to propeller solidity (helicopter C_T = thrust/$\rho A V_{TIP}^2$)
DIA	0226	DI	Propeller diameter (ft.)

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VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
EAS	0911-0920	EASS	Equivalent airspeed required during descent
EAS	0701-0710	EMACH	Equivalent airspeed required during climb
e	0306	DAM10	Span loading efficiency factor (Oswald's efficiency factor)
Δf_e	0307	DELFE	Increment in equivalent flat plate area parasite drag of fuselage (sq ft)
F_N*	0203	DAM8	Primary engine maximum static thrust at sea level, standard conditions (total thrust for all engines)
Gallery Area (ft^2)	0152	AGLLEY	Total area of the galley(s)
F_{NL}*	0219	DAM9	Lift engine maximum static thrust at sea level, standard conditions (total thrust for all engines)
Headwind	0811-0820	VIN	Headwind during cruise (knots)
h_o	0015	H00	Initial altitude at start of mission
h_c	0214	HC	Cruise altitude for sizing engines (feet)
h_{final} (h_{opt}IND=0) or h_{max}(h_{opt}IND=1)	1111-1120	HFIN(FT)	Final altitude for transfer altitude segment (SGTIND=9)
h_{max}	0741-0750	HMAX	Maximum, altitude during climb (feet) or during transfer altitude (feet)
h_{min}	0971-0980	HMIN	Minimum altitude during descent (feet)
h_i	0440-0449	TBH	Input altitude for non-standard atmosphere map.

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
K_{18}	0413	CK18	Fixed wing controls multiplicative weight factor
K_{19}	0414	CK19	SAS multiplicative weight factor
K_{20}	0415	CK20	Tilt mechanism multiplicative weight factor
K_{21}	0465	CK21	Fuel system multiplicative weight factor
K_{f}	0314	CKF	Fuselage multiplicative drag factor
K_{ff}	0026	CKFF	Fuel flow multiplicative drag factor
K_{ht}	0316	CKHT	Horizontal tail multiplicative drag factor
K_{ln}	0311	CKLN	Lift nacelle multiplicative drag factor
K_{n}	0313	CKN	Primary nacelle multiplicative drag factor
K_{pn}	1248-1257	PNZ	Ratio of power available at specified N_{II} to power available at optimum N_{II}
K_{pr}	1225-1234	RNE	Correction factor for engine power to account for Reynolds' number effects
K_{rc}	0262	CKRC	Multiplicative constant to be used to calculate takeoff vertical climb power, nominally 2.0 for turboshaft aircraft and lower for high disc loaded aircraft and fans
K_{vt}	0315	CKVT	Vertical tail multiplicative drag factor
K_{w}	0312	CKW	Wing multiplicative drag factor

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
LETF	0641-0650	FLET2	Lift engine thrust fraction. Required when TOLIND = 3
K_2'	0459	CK2	Propeller group multiplicative weight factor
K_3	0460	CK3	Drive system multiplicative weight factor
K_4	0461	CK4	Lift engine multiplicative weight factor
K_5	0462	CK5	Primary engine multiplicative weight factor
K_6	0463	CK6	Lift engine installation multiplicative weight factor
K_7	0464	CK7	Primary engine installation multiplicative weight factor
K_8	0433	CK8	Wing weight multiplicative weight factor
K_9	0434	CK9	Horizontal tail weight multiplicative weight factor
K_{10}	0435	CK10	Vertical tail weight multiplicative weight factor
K_{11}	0436	CK11	Fuselage weight multiplicative weight factor
K_{12}	0437	CK12	Landing gear weight multiplicative weight factor
K_{13}	0438	CK13	Lift engine section multiplicative weight factor
K_{14}	0439	CK14	Primary engine section multiplicative weight factor
K_{15}	0410	CK15	Cockpit controls multiplicative weight factor

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
K_{16}	0411	CK16	Upper controls multiplicative weight factor
K_{17}	0412	CK17	Hydraulics multiplicative weight factor
K_B	0420	SKP	Body group weight adjustment factor
K_{DS}	0453	SKDS	Drive system weight adjustment factor
K_{FS}	0454	SKFS	Fuel system weight adjustment factor
K_{lei}	0455	SKLEI	Lift engine installation weight factor
K_{les}	0421	SKLES	Lift engine section weight factor
K_{lg}	0422	SKLG	Weight of alighting gear as a percentage of gross weight
K_{mg}	0423	SKMG	Ratio of main alighting gear weight to gross weight
K_{mt}	0430	SKMT	Engine nacelle type factor
K_{nac}	0431	SKNAC	Engine nacelle adjustment factor
K_{pei}	0456	SKPEI	Primary engine installation weight factor
K_{pes}	0429	SKPES	Primary engine section weight factor
$K_{r/p}$	0457	SKRP	Rotor or propeller weight adjustment factor for type of system
K_{sas}	0407	SKSAS	Factor for stability augmented system and mixing units
K_{tl}	0424	SKTL	Tail load adjustment factor
K_{tm}	0408	SKTM	Multiplicative constant for tilting mechanism

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
K_{uc}	0409	SKUC	Multiplicative constant for upper control mechanicms
K_{vt}	0458	SKVT	Adjustment factor for variations in drive system weight due to nonuniformities in hover and XMSN tipspeeds or maximum and XMSN powers
K_{wf}	0425	SKWF	Wing bending relief moment adjustment factor
K_{ww}	0426	SKWW	Wing type weight adjustment factor
K_y	0427	SKY	Pitch radius of gyration, feet
K_z	0428	SKZ	Yaw radius of gyration, feet
Δh	0721-0730	DELH3	Step size for climb (feet)
Δh	0951-0960	DELHS	Step size for descent (feet)
h_F	0121	HF	Height of fuselage (feet)
h_{TO}	0207	HES	Takeoff altitude for sizing engines
i_w	0103	EYEW	Wing incidence angle with respect to fuselage (degrees)
k_1	1602	SK1	{ Lift engines weight factors
k_2	1603	SK2	
k_3	1302	SK3	{ Primary engine weight factors
k_4	1303	SK4	
K_{FL}	0531-0540	SKFL	Lift engine taxi segment factor (0 = lift engines off during taxi 1 = lift engines operating)
K_1	0024	CK1	Fuel required multiplicative reserve factor

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
K_{CC}	0404	SKCC	Cockpit controls constant
K_{DS}	0453	SKDS	Drive system weights constant
K_{FS}	0454	SKFS	Fuel system weights constant
K_{FW}	0405	SKFW	Fixed-wing controls constant
K_H	0406	SKH	System and hydraulics constant
K_{LEI}	0455	SKLEI	Lift engine installation factor
$l_{CONSTANT\ DIA}$	0125	ELC	Constant diameter section (cabin) length (feet)
l_F	0122	DAM5	Fuselage length (feet)
l_{MT}	0432	SKLMT	Distanct between engine center of gravity and closest structural attachment point between nacelle and wing, ratioed to length of nacelle
l_{RW}	0126	ELRW	Length of ramp well (feet)
l_{TN}	0111	ELTH	Horizontal tail moment arm (feet)
l_{TV}	0130	ELTV	Vertical tail moment arm (feet)
$(l/d)_{nose}$	0123	ELPD	Fineness ratio airplane nose section
$(l/d)_{tail}$	0124	ELTD	Fineness ratio airplane tail section
Mach	0701-0710	EAS5	Mach number required during climb
Mach	0911-0920	EMACH	Mach number required during descent
M_{LF}	0023	EMLF	Maneuver load factor (g's)
M_{MO}	0020	EMMO	Maximum operating mach number

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
N_C	0221	ENC	Number of clusters of lift engines
N_L	0220	ENL	Number of lift engines
N_{LO}	0212	ENLO	Number of lift engines inoperative (for engine sizing)
N_p	0204	ENP	Number of primary engines
N_{pO}	0211	ENPO	Number of primary engines inoperative (for engine sizing)
$N_{PSD_{CR}}$	0871-0880	ENPSD	Number of primary engines shut down during cruise
$N_{PSD\ LOITER}$	1051-1060	ENPSDL	Number of primary engines shut down during loiter
N_R	0223	ENR	Number of rotors or propellers
$(N_{I_{MAX}}/N_I^*)_L$	1236	A1LMAX	Gas generator RPM limit - ratio of max gas generator RPM to RPM at maximum static power, sea level, standard for lift engines
$(N_{I_{MAX}}/N_I^*)_L$	1221	A1MAX	Gas generator RPM limit - ratio of max gas generator RPM to RPM at maximum static power, sea level, standard for primary engines
$(N_I/\sqrt{\theta}/N_I^*)_{MAX}$	1222	A3MAX	Gas generator referred RPM limit (θ = temperature ratio @ compression face), this input simulates a restriction on compression speed

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
$N_{II}/N_{II_{OPT}}$	1238-1247	A2NO	Ratio of operating power turbine speed to optimum power turbine speed (input when N2IND = 2). $N_{II}/N_{II_{OPT}}$ is set = 1.0, and N_{II}/N_{IIMAX} is determined from $\frac{N_{II}}{N_{II_{OPT}}} = \frac{\frac{N_{II}}{N_{IIMAX}} \; \frac{N_{IIMAX}}{N_{II}^*}}{\frac{N_{II_{OPT}}}{N_{II}^*\sqrt{\theta}}} \quad \frac{1}{\sqrt{\theta}}$ If $N_{II}/N_{II_{MAX}}$ is much greater than 1.0, then set $N_{II}/N_{II_{MAX}}$ =1 and calculate $N_{II}/N_{II_{OPT}}$.
$(N_I/N_I^*)\frac{D}{v_1}$	1207-1216	PRN	Reynold's number correction for gas generator shaft speed (RPM)
$(N_I/N_{I_L}^*\sqrt{\theta})_1$	1649-1656	FONE	Values of referred gas generator shaft speed limit ratio, input as a function of referred temperature for lift engines
$(N_{II}/N_{II_L}^*\sqrt{\theta})_1$	1665-1672	FTWO	Values of referred power turbine speed limit ratio, input as a function of referred temperature for lift engines

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
$(N_{II}/N_{II_{MAX}})_C$	0217	AN2CR	Ratio of operating power turbine speed to maximum power turbine speed (input when sizing primary engines for cruise) If in cruise the rotor is slowed to a known velocity, $\left(\frac{N_{II}}{N_{II_{MAX}}}\right)_{CR}$ can be determined from $\left(\frac{N_{II}}{N_{II_{MAX}}}\right)_{CR} = \frac{V_{T_{OPERATING}}}{\frac{N_{II_{MAX}}}{N_{II}^*} V_{T_{REF}}}$ where V_T is input in LOC (0181), and $\frac{N_{II_{MAX}}}{N_{II}^*}$ is in LOC (1223).
$N_{II}/N_{II_{MAX_{TAXI}}}$	0591-0550	AN2M1	Ratio of operating power turbine speed to maximum power turbine speed (input for both primary and auxiliary independent engines in performance segemtn 1, TAXI. This value can be altered to obtain the desired operating tip velocity through the correlation $V_{T_{OPERATING}} = \frac{N_{II}}{N_{II_{MAX}}} \frac{N_{II_{MAX}}}{N_{II}^*} V_{T_{REF}}$ where $\frac{N_{II_{MAX}}}{N_{II}^*}$ is input in LOC (1223) and V_T is input in LOC (0181).

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
$\frac{N_{II}}{N_{II_{MAX_{TAKEOFF}}}}$	0671-0680	AN2M2	Ratio of operating power turbine speed to maximum power turbine speed (input for both primary and auxiliary independent engines in performance segment 2, TAKEOFF, HOVER, LAND
$\frac{N_{II}}{N_{II_{MAX_{CLIMB}}}}$	0771-0780	AN2M3	Ratio of operating power turbine speed to maximum power turbine speed (input for both primary and auxiliary independent engines in performance segement 3, CLIMB
$\frac{N_{II}}{N_{II_{MAX_{CRUISE}}}}$	0881-0890	AN2M4	Ratio of operating power turbine speed to maximum power turbine speed (input for both primary and auxiliary independent engines in performance segement 4, CRUISE
$\frac{N_{II}}{N_{II_{MAX_{DESC}}}}$	0981-0990	AN2M5	Ratio of operating power turbine speed to maximum power turbine speed (input for both primary and auxiliary independent engines in performance segement 5, DESCENT
$\frac{N_{II}}{N_{II_{MAX_{LOITER}}}}$	1061-1070	AN2M6	Ratio of operating power turbine speed to maximum power turbine speed (input for both primary and auxiliary independent engines in performance segement 6, LOITER
$\frac{N_{II}}{N_{II_{MAX_{TO}}}}$	0201	AN2TO	Ratio of operating power turbine speed to maximum power turbine speed (input when sizing primary engines for takeoff). This value is set to obtain the desired operating tip velocity at takeoff from the equation. $\frac{N_{II}}{N_{II_{MAX\ TO}}} = \frac{V_{T_{OPERATING}}}{\frac{N_{II_{MAX}}}{N_{II}^{*}} V_{T_{REF}}}$

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
$N_{II_{MAX}}/N_{II}*$	1223	A2MAX	Power turbine speed limit ratio of maximum power turbine speed to power turbine speed at maximum static power, sea level, standard for the primary engines.
$N_{II_{MAX}}/N_{II}*_L$	1237	AL2MAX	Power turbine speed limit ratio of maximum power turbine speed to power turbine speed at maximum static power, sea level, standard.
Number of Advance Ratios (J)	1701	XPXNO	Number of advance ratio values in locations 1702-1721
Atmosphere Temp. No. of Pairs	0416	THN	Number of temperature pairs in locations 0440-0449 & 0466-0475
No. of Aisles	0155	AN1SL1	Number of aisles in the first class section
No. of Aisles	0163	ANISLT	Number of aisles in the tourist class section
No. of Blades	0229	BLDN	Number of blades on prop/rotor
No. of Lavs.	0160	ANLAVS	Number of lavatories onboard
No. of CL.	0310	TCLZN	Number of CL values in locations 0343-0349
No. of M	1319	UMS	Number of mach number values in locations 1320-1325
No. of M	1383	UMW	Number of mach number values in locations 1384-1389
No. of M	1447	UNM1	Number of mach number values in locations 1448-1453
No. of M	1551	UNM2	Number of mach number values in locations 1512-1517

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
No. of M	0309	TENN	Number of mach numbers
No. of Pairs in Table	0308	TLLN	Number of pairs in $C_L \sim C_{Di}$ table
No. Pairs η_{p4} Table	0245	ETAP4N	Number of η_{p4} pairs in locations 0235-0255
No. of Passengers	0153	ANPX1	Number of passengers in the first class section of the aircraft
No. of Passengers	0161	ANPXT	Number of passengers in the tourist class section of the aircraft
No. of Prop Thrust Coefficients (C_T)	1722	CPPNO	Number of prop thrust coefficients in locations 1723-1742
No. of T/θ	1310	UNTS	Number of refered temperatures in locations 1311-1318
No. of T/θ	1374	UNTW	Number of refered temperatures in locations 1375-1382
No. of T/θ	1438	UNT1	Number of refered temperatures in locations 1439-1446
No. of T/θ	1502	UNT2	Number of refered temperatures in locations 1503-1510
n_T	0651-0660	ENT	Thrust-to-weight ratio during takeoff (Takeoff, Hover, and Landing Calculations Subroutine)
n	0208	SENE	Thrust-to-weight ratio for engine sizing
ΔNC_{LIMB}	0791-0800	ENCLIMB	Incremental normal load factor for energy-maneuverability calculations
OWE	0400	OWE1	Operating Weight Empty (pounds)
PETF or PEHF	0621-0630	PFET2	Primary engine power (or thrust) fraction. Required when TOLIND = 3.

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
ΔP_{PSI}	0450	DELP	Limit differential cabin pressure (PSI)
Q_{MAX}/Q^*	1224	QMAX	Ratio of maximum torque limit to torque developed at sea level static standard day conditions. See engine and transmission sizing for the options available.
R_o	0016	ROO	Initial range at start of mission (nautical miles)
$R_{MAX\ CRUISE}$	0851-0860	RMAX	Range at end of cruise (nautical miles)
$R_{MAX\ DESC.}$	0961-0970	RMAX5	Range at end of descent (nautical miles)
ΔR	0831-0840	DELR	Step size for cruise (nautical miles)
R_e/l_z	0330	RECI	Mean Reynold's number per foot for mission
r	0116	SR	Propeller blade attachment distance from hub center line (fraction of propeller radius)
S_F	0127	DAM6	Fuselage wetted area (FT^2)
S_{HT}	0115	AAW11	Area or horizontal tail. Used when HTIND = 2.
S_{VT}	0134	AAW12	Area of vertical tail. Used when VTIND = 2.
Seats Abreast	0162	ANABT	Seats abreast in tourist
Seats Abreast	0154	ANAB1	Seats abreast in first class
Seat Pitch	0157	PSEAT1	Seat pitch in first class
Seat Pitch	0165	PSEATT	Seat pitch in tourist

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
SHP*	0202	DAM7	Primary engine maximum static horsepower at sea level standard conditions (total power for all engines)
SHP_E/SHP*	0260	SHPTO	Fraction of power input for sizing engines; nominally input as 1.0
SHP_{XM}/SHP*	0258	XMSMRT	Fraction of power for transmission sizing
$\Delta S_{WET}/S_W$	0120	DLSWSW	Incremental wetted area of airplane ratioed to wing planform area
SW_F	0025	DELWF	Reserve fuel factor
t_o	0017	STOO	Initial time at start of mission hours
(t/c)HT	0112	TLCT	Horizontal tail mean thickness/chord ratio
(t/c)R	0104	TCR	Wing root thickness to chord ratio
(t/c)T	0105	TCT	Wing tip thickness chord ratio
(t/c)VT	0131	TCVT	Vertical tail mean thickness chord ratio
T_{FI}(°R)	1306	TFI	Turbine inlet temperature at flight idle power setting primary engines
T_{GI}(°R)	1305	TGI	Turbine inlet temperature at ground idle power setting primary engines
T_{GI}	1607	TLGI	Lift engine turbine inlet temperature at ground idle
t_H	0681-0690	STH	Incremental time for houer (HR)
Δt_H	0661-0670	DELTH	Step size for houer (Hours)

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
t_{FW}	1121-1130	STFW	Incremental time for change of fuel weight
ΔTin_{TAXI}(°F)	0521-0530	TIN1	Increment in ambient temperature for engine sizing at TAXI conditions (°R)
$\Delta Tin_{T/O}$(°F)	0631-0640	TIN2	Increment in ambient temperature for engine sizing at takeoff conditions (°R)
ΔTin_{CLIMB}(°F)	0731-0740	TIN3	Increment in ambient temperature for engine sizing at CLIMB conditions (°R)
ΔTin_{CRUISE}(°F)	0631-0640	TIN4	Increment in ambient temperature for engine sizing at CRUISE conditions (°R)
$\Delta Tin_{DESCENT}$(°F)	0941-0950	TIN5	Increment in ambient temperature for engine sizing at DESCENT conditions (°R)
ΔTin_{LOITER}(°F)	0041-1050	TIN6	Increment in ambient temperature for engine sizing at LOITER conditions (°R)
ΔTin_{TO}(°F)	0209	TINY	Increment in ambient temperature for engine sizing at takeoff conditions (°R)
ΔTin_{C}(°F)	0216	ATMIY	Increment in ambient temperature for engine sizing at cruise conditions (°R)
t_L (HR)	1031-1040		Incremental time for loiter (HRS)
Δt_L	1011-1020	DELST	Step size for loiter (HRS)
T_{MAX}	1608	TLMAX	Turbine inlet temperature (maximum power setting), or input on engine cycle sheets for lift engines
T_{MAX}(°R)	1309	TMAX	Turbine inlet temperature (maximum power setting), or input on engine cycle sheets

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
T_{MIL}(°R)	1308	TMIL	Turbine inlet temperature (military power setting), or input on engine cycle sheets
T_{NP}(°R)	1307	TNRP	Turbine inlet temperature (normal power setting), or input on engine cycle sheets
t_{pw} (HR)	1141-1150	STPW	Incremental time for change of payload weight (HRS)
t_T (HR)	0511-0520	DELTT	Incremental time for taxi (hours)
T/θ (Primary Engine Cycle No.)	1311-1318	TSHP	Referred turbine temperature (°R)
T/θ (Primary Engine Cycle No.)	1375-1382	TWD	Referred turbine temperature (°R)
T/θ (Primary Engine Cycle No.)	1439-1446	TN1	Referred turbine temperature (°R)
T/θ (Primary Engine Cycle No.)	1503-1510	TN2	Referred turbine temperature (°R)
Unit Seat Width	0156	WSEAT1	Input width of the seats in first class
Unit Seat Width	0164	WSEATT	Input width of the seats in tourist class
Values of η_{p4}	0246-0255	TB8AP4	Values of ETAPU in locations 0246-0255
Values of K_{PR}	1225-1234	RNE	Table of K_{PR} values
Values of M	0235-0244	TBEM5	Table of mach numbers for M-η_{p4} pairs for turboshaft engines

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
Values of M	1320-1325	AMSHP	Values of mach number for the referred thrust table
Values of M	1384-1389	AMWD	Values of mach number for the referred fuel flow table
Values of M	1448-1453	AM1	Values of mach number for the referred gas generator RPM limit
Values of M	1512-1517	AM2	Values of mach number for the referred power turbine RPM limit table
Values of N_I	1454-1501	AONE	Values of referred power generator RPM speed limit
Values of N_{II}	1518-1565	ATWO	Values of refered power turbine RPM speed limit
Values of Refered Thrust $(F_N/SF_{NL}^*)_1$	1609-1616	TF	Referred fuel flow as a function of (T/θ) for lift engines
Values of Refered Fuel Flow	1625-1632	TFW	function of (T/θ)
Values of Refered N_I	1641-1648	TF1	Referred N_I as a function of (T/θ) for lift engines
Values of Refered N_{II}	1657-1664	TF2	Referred N_{II} as a function of (T/θ) for lift engines
Values of Refered Thrust or Horsepower	1326-1373	SHPAV	Table of power available referred to T/θ
Values of Fuel Flow	1390-1437	WDOT	Values of fuel flow as a function of (T/θ)

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
Values of M	0325-0329	TBEM	Table of mach numbers used in generating compressibility effect
$V_{R/C}$	2321-2330	VRCTO	Vertical rate of climb in FT/MIN for takeoff, hover, and landing segment
$V_{R/CTAKEOFF}$	0261	VRCRC	Vertical rate of climb in FT/MIN for engine sizing for takeoff
V_{TIP}	0224	VT	Propeller tip speed (fps) Note: for ENGIND ≠ 0 this is the tip speed corresponding to $N_{II} = N^*_{II}$
$\bar{V}_v$	0132	VBARV	Vertical tail volume coefficient
W_c	0451	WC	Weight of concentrated load
W_{FE}	0401	WFE	Weight of fixed equipment
W_{FUL}	0402	WFUL	Weight fixed useful load
W_{go}	0014	WGOO	Initial gross weight at start of mission (pounds)
W_g/A	0225	WGA	DISC loading (psf)
W_{PL}	0403	WPL	Weight of payload (pounds)
W_g/S	0106	DAM4	Wing loading (psf)
ΔW_{FC}	0417	DELWFZ	Flight controls group incremental weight (pounds)
ΔW_F	1101-1110	DLTAWF	Increment in fuel weight during change of fuel weight subroutine (pounds)
ΔW_P	0418	DELWP	Propulsion group incremen-

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
Values of J	1702-1721	XPJ	Table of prop advance ratio
V_C	0215	VC	True airspeed for engine sizing at cruise conditions
V_{DIVE}	0022	VDIV	Dive speed (knot gas)
V_{IN}	0811-0820	VIN	True airspeed for cruise during cruise segment with CRSIND = 2 (knots)
V_{MO}	0021	VMO	Maximum operative equivalent airspeed (knots)
$\bar{V}_H$	0113	VBARH	Horizontal tail volume coefficient
ΔW_{PL}	1131-1140	DELWPL	Increment in payload weight during change of payload weight subroutine (pounds)
ΔW_{ST}	0419	DELWST	Structures group incremental weight (LBS)
W_F	0128	SWF	Width of fuselage
$\overset{*}{W}_{MAX}/\overset{*}{W}$	1220	WMAX	Referred fuel flow cutoff for primary engines

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
$\dot{W}^{*}_{MAX}/\dot{W}^{*}_{L}$	1235	WLMAX	Referred fuel flow cutoff for lift engines
$W_f/\delta\sqrt{\theta}F^{*}_{NL}$	1633-1640	FWDOT	Referred fuel flow rate for lift engines (lbs/hr/lb F^{*}_{NL})
$W_f/\delta\sqrt{\theta}F^{*}_{n}$ $W_f/\delta\sqrt{\theta}SHP^{*}$	1390-1437	WDOT	Referred fuel flow rate for primary engines (lbs/hr/lb F^{*}_{N} or lbs/hr/SHP*)
(W/S Wing & Flap/(W/S) Wing	1081-1090	RSW	Wing area increase due to flap extension
Y_c	0452	YC	Position of concentrated load outboard from aircraft ℄ (fraction of wing semi span)
Y_u	0117	YCL	Clearance from inboard propeller tip to inboard propeller tip across fuselage (feet)
Y_l	0137	YL	Mean position of lift engines outboard from aircraft ℄ (fraction of wing semi span)
Y_{mg}	0135	YMG	Position of main landing gear outboard from side of body (fraction of wing semi-span)

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
Y_p	0136	YP	Mean position of primary engines outboard from airplane ℄ (fraction of wing semi span)
Z_1	0139	AZETA1	Primary engine nacelle dimensional factors
Z_2	0140	AZETA2	
Z_3	0141	AZETA3	
α_{LO}	0332	ALPHL	Angle of attack where zero lift occurs
β	020S	BETA	Conversion ratio for convertible engines (lbs/hp)
ε	0138	EPSLON	Life engine cluster gap factor (see Section 2.1)
ζ	0118	ZETA1	Propeller over propeller overlap fraction of radius

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
ζ	0119	ZETA2	Propeller over wingtip overlap (fraction of radius)
η_L	0231	ETAC	Lift engine efficiency for Takeoff, Hover, and Landing Calculations Subroutine
η_{P2}	0232	ETAP2	Primary engine propulsive efficiency for SGTIND = 2
η_{P3}	0233	ETAP3	Primary engine propulsive efficiency for SGTIND = 3
η_{P5}	0234	ETAP5	Primary engine propulsive efficiency for SGTIND = 5
η_T	0206	ETAT	Transmission efficiency
θ	0466-0475	TBTHE	Ambient tempeture ratio, tabular function of altitude
θ_{max}(OEG)	0761-0770	THEMAX	Maximum body attitude angle, climb (degrees)
θ_{min}(DEG)	0931-0940	THEMIN	Minimum body attitude angle, descent (degrees)
$\Lambda c/4$	0104	DLMC4	Sweep angle of wing quarter chord (degree)
λ	0108	SLM	Taper ratio of wing
λH	0114	SLMH	Taper ratio of horizontal tail
λv	0133	SLMV	Taper ratio of vertical tail
$\xi 1$	1604	XI1	
$\xi 2$	1605	XI2	Lift engine dimensional factors
$\xi 3$	1606	XI3	
$\xi 4$	1304	XI4	Primary engine dimensional factor

5.3.2 Program Indicators

Option Indicators

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
OPTIND	0001	OPTIND	1 = size aircraft 2 = calculate performance (specify initial gross weight) 3 = calculate performance (specify operating weight empty)
OPTIONAL PRINT	0002	TNIRPK	0 = Standard print 1 = Detailed print

Propulsion Indicators

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
ENGIND	0011	ENGIND	0 = turboshaft (power producing) engine 1 = turbofan or turbojet (thrust producing) engine 2 = convertible engine
LFTIND	0013	DNITFL	0 = no lift propulsion engine selected 1 = lift propulsion engine selected
FIXIND	0010	FIXIND	0 = "fixed" size engines. User inputs maximum power or thrust. 1 = "rubberized" engines. Program will calculate maximum power or thrust.

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
The following five indicators are for primary engines:			
WDTIND	1201	WGTIND	0 = no fuel flow limit
			1 = fuel flow limit
QIND	1205	QIND	0 = no torque limit
			1 = torque limit
N1IND	1202	AN1IND	0 = no N_I limit
			1 = N_I limit
N1θIND	1203	AN3IND	0 = no $N_I/\sqrt{\theta_1}$ limit
			1 - $N_I/\sqrt{\theta_1}$ limit
N2IND	1204	AN2IND	0 = no N_{II} limit. Engine operating at optimum N_{II}
			1 = N_{II} limit. Engine operating at optimum N_{II}
			2 = N_{II} limit. Engine operating at known value of N_{II} (in general, non-optimum)
The following four indicators are for lift engines:			
LWDIND	1217	VWDIND	0 = no fuel flow limit
			1 = fuel flow limit
LNIND	1218	VN1IND	0 = no N_I limit
			1 = N_I limit
LN2IND	1219	VN2IND	0 = no N_{II} limit
			1 = N_{II} limit
RNOIND	1206	RNOIND	0 = no Reynolds' number corrections for Primary Engines

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
POWIND	0751-0760	POWCLI	1 = Reynolds' number corrections
POWIND	0861-0870 or 0213	POWCRI POWESI	0 = maximum engine rating
			1 = military engine rating
			2 = normal engine rating

(The indicator listed below is applicable only if LFTIND = 0 and FIXIND = 1)

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
ESZIND	0012	ESZIND	0 = program will size engines for takeoff only
			1 = program will size engines for more critical choice of takeoff or cruise

Aerodynamics Indicators

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
DRGIND	0003	DRGIND	0 = program calculates compressibility drag coefficient
			1 = user inputs table of compressibility drag coefficient as a function of Mach number and lift coefficient

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
OSWIND	0004	OSWIND	0 = user inputs Oswald's efficiency (e)
			1 = program calculates Oswald's efficiency
Size Trends Indicators			
FDMIND	0006	FDMIND	0 = user inputs fuselage length and wetted area
			1 = user inputs constant diameter (cabin) length, nose and tail fineness ratios. Program calculates total length and wetted area.
			2 = user inputs $(\ell/d)_{NOSE}$, $(\ell/d)_{TAIL}$, and passenger data. Program calculates fuselage dimensions required to accommodate passengers.
WDMIND	0007	WDMIND	0 = user inputs wing loading and aspect ratio
			1 = user inputs chord to diameter ratio and disc loading. Program calculates wing loading and aspect ratio.
			2 = user inputs wing loading and disc loading. Program calculates chord to diameter ratio and aspect ratio.
HTIND	0008	HTIND	1 = input horizontal tail volume coefficient and moment arm. Program calculates tail area.
			2 = input tail area

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
VTIND	0009	VTIND	1 = input vertical tail volume coefficient and moment arm. Program calculates tail area.
			2 = input tail area
PDMIND	0005	PDMIND	1 = input prop diameter and activity factor per blade
			2 = input prop disc loading and activity factor per blade
			3 = input prop diameter and thrust coefficient to solidity ratio
			4 = input prop disc loading and thrust coefficient to solidity ratio
XSMNIND	0218	XMSND	0 = aircraft transmission sized at a specified fraction (LOC 0258) of installed power
			1 = aircraft transmission sized at a specified fraction (LOC 0258) of power required to hover or cruise power required, whichever is most critical.
GALLERY INDICATOR	0151	DNI1GN	0 = program calculates galley area by trend equation
			1 = user inputs galley area
LAVATORY	0159	DNIVAL	0 = program calculates number of lavatories by trend equation
			1 = user inputs number of lavatories

Flight Path Control Indicators

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
λ_{opt}IND	0018	HOPTIND	0 = cruise segments performed at specified altitude
			1 = cruise segments preceded by climb or transfer altitutde are performed at optimum altitude, constrained by an input maximum altitude.
VLIMIND	0019	VLMIND	0 = no constraint or equivalent airspeed
			1 = equivalent airspeed constrained to be less than or equal to 250 knots at altitudes of 10,000 feet or less

Mission Performance Indicators

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
SGTIND	0027-0076	SGTIND	0 = end of mission
			1 = taxi
			2 = takeoff, hover and landing
			3 = climb
			4 = cruise
			5 = descent
			6 = loiter
			7 = change of fuel weight
			8 = change of payload weight
			9 = transfer altitude
			10 = X-Y Plotter output
			11 = general performance
			100 = end of case

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
TOLIND	0601-0610	TOLIND	1 = input required thrust-weight ratio. Airplane will use maximum power from lift engines before augmenting with primary engines--or--will use only primary engines if LIFTIND = 0.
			2 = input required thrust-weight ratio. Airplane will use equal percentages of power from lift and primary engines.
			3 = input required fraction of maximum power
CLMIND	0691-0700	CLMIND	1 = maximum rate of climb
			2 = climb at constant EAS
			3 = climb at constant Mach number
			4 = climb at constant true airspeed
CRSIND	0801-0810	CRSIND	1 = cruise at cruise power
			2 = cruise at constant true airspeed
			3 = cruise at speed for best specific range
			4 = cruise at speed for 99% of best specific range
			5 = cruise-climb (constant W/δ) at speed for best specific range
			6 = cruise-climb (constant W/δ) at speed for 99% of best specific range

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
DESIND	0901-0910	DESIND	1 = descend at maximum speed, terminal range specified 2 = descend at maximum speed, terminal range not specified 3 = descend at idle power, terminal range specified 4 = descend at idle power, terminal range not specified 5 = descend at constant EAS, terminal range specified 6 = descend at constant EAS, terminal range not specified 7 = descend at constant Mach number, terminal range specified 8 = descend at constant Mach number terminal range not specified
LTRIND	1001-1010	DNIRTL	0 = loiter mission used for reserve fuel calculation (gross weight reset following loiter) 1 = loiter mission used as part of basic mission profile (gross weight not reset)
WGTIND	1151	WGTIND	0 = restriction on maximum airplane weight. Weight cannot exceed gross weight. 1 = no restriction on airplane weight (will only apply when running performance)

Atmosphere Indicator

VARIABLE	LOCATION	FORTRAN NAME	DESCRIPTION
ATMIND	0501-0510	ATMIN1	0 = standard atmosphere
	0611-0620	ATMIN2	1 = non-standard atmosphere. User inputs single point value for increment in ambient temperature above standard day value.
	0711-0720	ATMIN3	
	0821-0830	ATMIN4	
	0921-0930	ATMIN5	2 = non-standard atmosphere. User inputs table of temperature ratio as a function of altitude.
	1021-1030	ATMIN6	
	2221-2230	ATMIN7	

5.3.3 FORTRAN VARIABLES

FORTRAN VARIABLE	PROGRAM VARIABLE	INPUT LOCATION
A1LMAX	$(N_{I_{MAX}}/N^*_I)_L$	1236
A1MAX	$N_{I_{MAX}}/N_{I^*}$	1221
A2MAX	$N_{II_{MAX}}/N^*_{II}$	1223
A2NO	N_{II}/N_{II} OPT	1238 - 1247
A3MAX	$(N_I\sqrt{\theta_1}/N^*_I)$MAX	1222
AAW11	S_{HT}	0115
AAW1Z	S_{VT}	0134
AF	ACTIVITY FACTOR PER BLADE	0228
AGLLEY	GALLEY AREA (FT^2)	0152
AL2MAX	$(N_{II_{MAX}}/N^*_{II})_L$	1237
ALPHL	α_{LO} (DEG)	0332
AM1	VALUES OF M	1448 - 1453
AM2	VALUES OF M	1512 - 1517
AMSHP	VALUES OF M	1320 - 1325
AMWD	VALUES OF M	1384 - 1389
AN1IND	N1IND	1202
AN2CR	$(N_{II}/N_{II_{MAX}})_C$	0217
AN2IND	N2IND	1204
AN2M1	$N_{II}/N_{II_{MAX}}$ - TAXI	0541 - 0550
AN2M2	$N_{II}/N_{II_{MAX}}$ - TAKEOFF	0671 - 0680
AN2M3	$N_{II}/N_{II_{MAX}}$ - CLIMB	0771 - 0780
AN2M4	$N_{II}/N_{II_{MAX}}$ - CRUISE	0881 - 0890
AN2M5	$N_{II}/N_{II_{MAX}}$ - DESCENT	0981 - 0990
AN2M6	$N_{II}/N_{II_{MAX}}$ - LOITER	1061 - 1070

FORTRAN VARIABLE	PROGRAM VARIABLE	INPUT LOCATION
AN2M7	$N_{II}/N_{II_{MAX}}$ - T/O GEN. PERF.	2281
AN2M8	$N_{II}/N_{II_{MAX}}$ - CR. GEN. PERF.	2311
AN2TO	$(N_{II}/N_{II_{MAX}})TO$	0210
AN3IND	N1θIND	1203
ANAB1	SEATS ABREAST	0154
ANABT	SEATS ABREAST	0162
ANISL1	NO. OF AISLES	0155
ANISLT	NO. OF AISLES	0163
ANLAVS	NO. OF LAVATORIES	0160
ANPX1	NO. OF PASSENGERS	0153
ANPXT	NO. OF PASSENGERS	0161
ACNE	VALUES OF REFERRED N_I	1454 - 1501
ARHT	AR_{HT}	0109
ARVT	AR_{VT}	0129
ATMIN1	ATMIND	0501 - 0510
ATMIN2	ATMIND	0611 - 0620
ATMIN3	ATMIND	0711 - 0720
ATMIN4	ATMIND	0821 - 0830
ATMIN5	ATMIND	0921 - 0930
ATMIN6	ATMIND	1021 - 1030
ATMIY	ΔTin_c	0216
ATWO	VALUES OF REFERRED N_{II}	1518 - 1565
AXETA1	η_1	0139
AZETA2	η_2	0140
AZETA3	η_3	0141

FORTRAN VARIABLE	PROGRAM VARIABLE	INPUT LOCATION
BETA	β	0205
BLDN	NO. OF BLADES	0229
CDHTI	C_{DHTi}	0302
CDLNI	C_{DLNi}	0304
CDNI	C_{DNi}	0303
CDVTI	C_{DVTi}	0301
CK1	K_1	0024
CK10	K_{10}	0435
CK11	K_{11}	0436
CK12	K_{12}	0437
CK13	K_{13}	0438
CK14	K_{14}	0439
CK15	K_{15}	0410
CK16	K_{16}	0411
CK17	K_{17}	0412
CK18	K_{18}	0413
CK19	K_{19}	0414
CK2	K_2	0459
CK20	K_{20}	0415
CK21	K_{21}	0465
CK3	K_3	0460
CK4	K_4	0461
CK5	K_5	0462
CK6	K_6	0463
CK7	K_7	0464

FORTRAN VARIABLE	PROGRAM VARIABLE	INPUT LOCATION
CK8	K_8	0433
CK9	K_9	0434
CKF	K_F	0314
CKFF	K_{FF}	0026
CKHT	K_{HT}	0316
CKLN	K_{LN}	0311
CKN	K_N	0313
CKRC	$K_{R/C}$	0262
CKVT	K_{VT}	0315
CKW	K_W	0312
CLEYE	C_{L_i}	0230
CLMIND	CLMIND	0691 - 0700
CPPNO	NO.OF PROP TRUST CO-EFFICIENTS (C_T)	1722
CPPROP	VALUES OF C_T	1723 - 1742
CRSIND	CRSIND	0801 - 0810
CSALF	$C_{L\alpha}$ (RAD^{-1})	0331
CTPROP	VALUES OF PROPELLER POWER COEFFICIENT	1743 - 2142
CTSIG	C_T/σ	0227
CYCLFL	CYCLE NO.	1601
CYCLFP	LIFT ENGINE CYCLE NO.	0218
CYCPRL	CYCLE NO.	1301
CYCPRP	PRIMARY ENGINE CYCLE NO.	0201
CYPROP	PROPELLER TABLE NO.	0256

FORTRAN VARIABLE	PROGRAM VARIABLE	INPUT LOCATION
D1	DIA	0226
DAM10	e	0306
DAM2	AR	0101
DAM3	C/D	0102
DAM4	W /S	0106
DAM5	1F	0122
DAM6	S_F	0127
DAM7	SHP_P^*	0202
DAM8	F_N^*	0203
DAM9	F_{NL}^*	0219
DCLIMB	ΔCD CLIMB	0781 - 0790
DELCD	ΔCD	0305
DELFE	Δfe (FT^2)	0307
DELH3	Δh (FT)	0721 - 0730
DELH5	Δh (FT)	0951 - 0960
DELP	ΔP (P.S.I.)	0450
DELR	ΔR (NM)	0831 - 0840
DELST	Δt_L (HR)	1011 - 1020
DELTH	Δt_H (HR)	0661 - 0670
DELTT	Δt_T (HR)	0511 - 0520
DELWF	ΔWf	0025
DELWFZ	ΔW_{FC} (LBS)	0417
DELWP	ΔW_P (LBS)	0418
DELWPL	ΔW_{PL} (LBS)	1131 - 1140
DELWST	ΔW_{ST} (LBS)	0419

FORTRAN VARIABLE	PROGRAM VARIABLE	INPUT LOCATION
DESIND	DESIND	0901 - 0910
DLCDCR	ΔC_D CR	0891 - 0900
DLCDDS	ΔC_D DESC.	0991 - 1000
DLMCH	$\Lambda c/4$	0107
DLOITR	ΔC_D LOITER	1071 - 1080
DLSWSW	$\Delta S_{WET}/S_W$	0120
DLTAWF	ΔW_F (LBS)	1101 - 1110
DNILGN	GALLEY INDICATOR	0151
DNIRTL	LTRIND	1001 - 1010
DNITFL	LFTIND	0013
DNIVAL	LAVATORY INDICATOR	0159
DRGIND	DRGIND	0003
DSHPAC	ΔSHP_{acc}	0259
EAS5	MACH OR EAS (KTS)	0911 - 0920
ELC	$L_{CONST.\ DIA.}$	0125
ELPD	$(^L/d)$ NOSE	0123
ELRW	l_{RW}	0126
ELTD	$(^L/d)_{TAIL}$	0124
ELTH	l_{TH}	0111
ELTV	l_{TV}	0130
EMACH	MACH OR EAS (KTS)	0701 - 0710
EMLF	M_{LF}	0023
EMMO	M_{MO}	0020
ENC	N_c	0221
ENCLIMB	Δ_n CLIMB (E-M CALCS)	0791 - 0800
EYEW	i_W	0103

FORTRAN VARIABLE	PROGRAM VARIABLE	INPUT LOCATION
ENGIND	ENGIND	0011
ENL	N_L	0220
ENL0	N_{L0}	0212
ENP	N_P	0204
ENP0	N_{P0}	0211
ENPSD	$N_{PSD_{CR}}$	0871 - 0880
ENR	N_R	0223
ENPSDL	$N_{PSD_{LOITER}}$	1051 - 1060
ENT	n_T	0651 - 0660
EPSLON	ε	0138
ESZIND	ESZIND	0012
ETAIND	η_P IND	0200
ETAL	η_L	0231
ETAP2	η_{P2}	0232
ETAP3	η_{P3}	0233
ETAP4N	NO. OF PAIRS IN η_{P4} TABLE	0245
ETAP5	η_{P5}	0234
FAVL	$(F_N/F^*_{NL})1$	1617 - 1624
FDMIND	FDMIND	0006
FIXIND	FIXIND	0010
FLET2	LETF	0641 - 0650
FONE	$(N_I/N^*_{IL}\sqrt{\theta})1$	1649 - 1656
FTWO	$(N_{II}/N^*_{II_L}\sqrt{\theta})1$	1665 - 1672
FWDOT	$(W_f/\delta\sqrt{\theta}F^*_{NL})1$	1633 - 1640

FORTRAN VARIABLE		PROGRAM VARIABLE	INPUT LOCATION
HC		h_c	0214
HES		h_{TO}	0207
HF		h_F	0121
HFIN		h_{FINAL} (FT)(h_{OPT} IND=0)	1111 - 1120
	OR	h_{MAX} (FT)(h_{OPT} IND=1)	
HMAX		h_{MAX} (FT)	0741 - 0750
HMIN		h_{MIN} (FT)	0971 - 0980
HOO		h_0	0015
HOPTIN		h_{OPT} IND	0018
HTIND		HTIND	0008
OPTIND		OPTIND	0001
OSWIND		OSWIND	0004
OWE1		OWE	0400
PDMIND		PDMIND	0005
PFET2		PETF OR PEHF	0621 - 0630
PN2		K_{PN}	1248 - 1257
POWCLI		POWIND	0751 - 0760
POWCRI		POWIND	0861 - 0870
POWESI		POWIND	0213
PRN		$(N_I/N_I^*)(D/v_1)$	1207 - 1216
PROPCY		PROP. TABLE NO.	1700
PSEAT1		SEAT PITCH (IN)	0157
PSEATT		SEAT PITCH (IN)	0165

FORTRAN VARIABLE	PROGRAM VARIABLE	INPUT LOCATION
QIND	QIND	1205
QMAX	Q_{MAX}/Q^*	1224
RELI	R_e/l_i	0330
RMAX	R_{MAX} (NM)	0851 - 0860
RMAX5	R_{MAX} (NM)	0961 - 0970
RNE	VALUES OF K_{PR}	1225 - 1234
RNOIND	RNOIND	1206
R00	R_0	0016
RSW	$((W/S)_{WING+FLAP}/(W/S)_{WING})$	1081 - 1090
SAH	a_H	0110
SENE	n	0208
SGTIND	SGTIND	0027 - 0076
SHPAV	VALUES OF REFERRED THRUST OR HORSEPOWER	
SHPTO	SHP_E/SHP^*	0260
SK1	k_1	1602
SK2	k_2	1603
SK3	k_3	1302
SK4	k_4	1303
SKCC	k_{CC}	0404
SKDS	k_{DS}	0453
SKFL	k_{FL}	0531 - 0540
SKFS	k_{FS}	0454
SKFW	k_{FW}	0405
SKH	k_H	0406
SKLEI	k_{LEI}	0455

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FORTRAN VARIABLE	PROGRAM VARIABLE	INPUT LOCATION
SKLES	k_{LES}	0421
SKLG	k_{LG}	0422
SKLMT	l_{MT}	0432
SKMG	k_{MG}	0423
SKMT	k_{MT}	0430
SKNAC	k_{NAC}	0431
SKP	k_B	0420
SKPEI	k_{PEI}	0456
SKPES	k_{PES}	0429
SKRP	$k_{R/P}$	0457
SKSAS	k_{SAS}	0407
SKTL	k_{TL}	0424
SKTM	k_{TM}	0408
SKUC	k_{UC}	0409
SKVT	k_{VT}	0458
SKWF	k_{WF}	0425
SKWW	k_{WW}	0426
SKY	κ_Y	0427
SKZ	k_Z	0428
SLM	λ	0108
SLMH	λ_H	0114
SLMV	λ_V	0133
SR	r	0116
ST00	t_0	0017
STFW	t_{FW}(HR)	1121 - 1130

FORTRAN VARIABLE	PROGRAM VARIABLE	INPUT LOCATION
STH	t_H(HR)	0681 - 0690
STL	t_L(HR)	1031 - 1040
STPW	t_{PW}(HR)	1141 - 1150
SWF	F	0128
TB8AP4	VALUES OF η_{P4}	0246 - 0255
TBCDM	VALUES OF C_{DM}	0350 - 0384
TBCDWI	VALUES OF C_{DWI}	0335 - 0342
TBCL1	VALUES OF C_L	0317 - 0324
TBCL2	VALUES OF C_L	0343 - 0349
TBEM	VALUES OF M	0325 - 0329
TBEM5	VALUES OF M	0235 - 0244
TBH	h_1 (FT)	0440 - 0449
THN	ATMOSPHERE TEMP NO. OF PAIRS	0416
TBTHE	θ_1	0466 - 0475
TCL1N	NUMBER OF C_L	0310
TCLN	NO. OF PAIRS IN TABLE	0308
TCR	$(t/c)_R$	0104
TCT	$(t/c)_T$	0105
TCVT	$(t/c)_{VT}$	0131
TENN	NUMBER OF M	0309
TF	REFERRED THRUST AS A FUNCTION OF (T/θ)	1609 - 1616
TF1	REFERRED N_1 AS A FUNCTION OF (T/θ)	1641 - 1648
TF2	REFERRED N_{II} AS A FUNCTION OF (T/θ)	1657 - 1664

FORTRAN VARIABLE	PROGRAM VARIABLE	INPUT LOCATION
TFI	T_{F_I} (°R)	1306
TFW	REFERRED FUEL FLOW AS A FUNCTION OF (T/θ)	1625 - 1632
TGI	T_{G_I} (°R)	1305
THEMAX	θ_{MAX} (DEG)	0761 - 0770
THEMIN	θ_{MIN} (DEG)	0931 - 0940
TIN1	ΔTin (°F) (TAXI)	0521 - 0530
TIN2	ΔTin (°F) (TO, HOVER AND LANDING)	0631 - 0640
TIN3	ΔTin (°F) (CLIMB)	0731 - 0740
TIN4	ΔTin (°F) (CRUISE)	0841 - 0850
TIN5	ΔTin (°F) (DESCENT)	0941 - 0950
TIN6	ΔTin (°F) (LOITER)	1041 - 1050
TIN7	ΔTin (°F) (GENERAL PERF.)	2241 - 2250
TINY	ΔTin (°F) (TO)	0209
TLCT	$(t/c)_{HT}$	0112
TLGI	T_{GI}	1607
TLMAX	T_{MAX}	1608
TMAX	T_{MAX} (°R)	1309
TMIL	T_{MIL} (°R)	1308
TN1	T/θ (PRIMARY ENGINE CYCLE NO.)	1439 - 1446
TN2	T/θ (PRIMARY ENGINE CYCLE NO.)	1503 - 1510
TNIRPK	OPTIONAL PRINT	0002
TNRP	T_{NP}(°R)	1307
TOLIND	TOLIND	0601 - 0610

FORTRAN VARIABLE	PROGRAM VARIABLE	INPUT LOCATION
TSHP	T/θ PRIMARY ENGINE CYCLE	1311 - 1318
TWD	T/θ PRIMARY ENGINE CYCLE	1375 - 1382
UMS	NO. OF M	1319
UMW	NO. OF M	1383
UNM1	NO. OF M	1447
UNM2	NO. OF M	1511
UNT1	NO. OF T/θ	1438
UNT2	NO. OF T/θ	1502
UNTS	NO. OF T/θ	1310
UNTW	NO. OF T/θ	1374
VBARH	V_H	0113
VBARV	V_V	0132
VC	VC	0215
VDIV	V_{DIVE}	0022
VIN	VIN OR HEADWIND	0811 - 0820
VLMIND	V_{LIM} IND	0019
VMO	V_{MO}	0021
VN1IND	LN1IND	1218
VN2IND	LN2IND	1219
VRCRC	$V_{R/C}$	0261
VRCTO	$V_{R/C}$ - TAKEOFF	2321 - 2330
VT	V_{TIP}	0224
VTIND	VTIND	0009
VWDIND	LWDIND	1217
WAISL1	AISLE WIDTH (IN.)	0158
WAISLT	AISLE WIDTH (IN.)	0166

FORTRAN VARIABLE	PROGRAM VARIABLE	INPUT LOCATION
WC	W_C (LBS)	0451
WDMIND	WDMIND	0007
WDOT	VALUES OF REFERRED FUEL FLOW	1390 - 1437
WDTIND	WDTIND	1201
WFE	W_{FE} (LBS)	0401
WFUL	W_{FUL} (LBS)	0402
WGA	$W_{G/A}$	0225
WG00	W_{G_0}	0014
WGTIND	WGTIND	1151
WLMAX	$(\overset{*}{W}_{MAX}/\overset{*}{W}*)L$	1235
WMAX	$(\overset{*}{W}_{MAX}/\overset{*}{W}*)$	1220
WPL	W_{PL} (LBS)	0403
WSEAT1	UNIT SEAT WIDTH (IN)	0156
WSEATT	UNIT SEAT WIDTH (IN)	0164
XCPS	(X/C)	0333
XCTCM	$(X/C)_{max\ t/c}$	0334
XI1	ξ_1	1604
XI2	ξ_2	1605
XI3	ξ_3	1606
XI4	ξ_4	1304
XMSMRT	$SHP_{xm}/SHP*$	0258
XMSND	XMSNDIND	0257
XPJ	VALUES OF J	1702 - 1721
XPXNC	NO. OF ADVANCE RATIOS (J)	1701

FORTRAN VARIABLE	PROGRAM VARIABLE	INPUT LOCATION
YC	Y_c	0452
YCL	Y_{cl}	0117
YL	Y_1	0137
YMG	Y_{MG}	0135
YP	Y_P	0136
ZETA1	η_1	0118
ZETA2	η_2	0119

6.0 PROGRAM OUTPUT

A reproduction of the program output for two sample cases is included in Section 7.0. The following discussion describes the program printout in general and lists the diagnostic error printouts which are possible.

6.1 DESCRIPTION OF PRINTOUT

The printout for VASCOMP II consists of four types of information:

a. General
b. Input Data
c. Sizing Data (program output)
d. Mission Performance Data (for the "sized" airplane)

The general information (item a) is printed out at the beginning of each new case. Each of the other groupings (input, sizing data, and performance data) starts on a new page. For cases with OPTIND = 2 or 3 (performance only), the sizing data is not printed out. The printout is described in detail below.

6.1.1 General Printout

6.1.1.1 Fixed Heading:

V A S C O M P I I

V/STOL AIRCRAFT SIZING AND PERFORMANCE COMPUTER PROGRAM

6.1.1.2 Arbitrary Heading

An arbitrary heading may be input by the user on a title card (see Section 5.2, input sheet for general information).

6.1.2 Input Data

All program input data is printed out as it appears on the data cards. Seven columns are printed. These correspond to the first location on the card, the number of variables on the card (from 1 to 5), and the values of these variables. With this information and a copy of the input sheets it is possible to determine the input value for any variable.

6.1.3 Sizing Data

This group is printed out only if OPTIND = 1. The data is represented by a symbol, followed by a written description, followed by the value with the units. For example:

WG/A DISC LOADING 45.0 LB/SQFT

The data is printed out in groups, each group having a heading. The specific variables which are printed out will depend upon certain options chosen. Notations are made in the following list to show where this occurs.

6.1.3.1 Dimensional Data

Fuselage:

ℓ_F, w_F, S_F

Wing:

AR, S_W, b, c_W, $\Lambda_{c/4}$, λ, $(t/c)_R$, $(t/c)_T$,

W_G/S, $\overline{C/D}$ (print $\overline{C/D}$ only if WDMIND = 1, 2 or ENGIND = 0, 2)

Horizontal Tail:

AR_{HT}, S_{HT}, b_{HT}, c_{HT}, $(t/c)_{HT}$, ℓ_{TH}

(print ℓ_{TH} only if HTIND = 1)

Vertical Tail:

AR_{VT}, S_{VT}, b_{VT}, c_{VT}, $(t/c)_{VT}$, ℓ_{TV}

(print ℓ_{TV} only if VTIND = 1)

Primary Engine Nacelle:

ℓ_N, $\bar{d}_N$, S_N

Lift Engine Nacelle:

i.) If LFTIND = 1 print: ℓ_{LN}, $\bar{d}_{LN}$, S_{LN}

ii.) If LFTIND = 0 print: NO LIFT PROPULSION SELECTED

Propeller:

i.) If ENGIND = 0 or 2 print: D, $\sigma_{R/P}$, W_G/A, C_T/σ, N_R, No. Blades

ii.) If ENGIND = 1 print: NO PROPELLER ON THIS AIRCRAFT

Passenger Sizing Data:

If FDMIND = 2, print the following data:

	TOURIST	FIRST CLASS
NO. OF PASS.	XX.	YY.
NO. ABREAST	XX.	YY.
NO. OF AISLES	XX.	YY.
UNIT SEAT WIDTH	XX. IN.	YY. IN.
SEAT PITCH	XX. IN.	YY. IN.
AISLE WIDTH	XX. IN.	YY. IN.

NUMBER OF LAVATORIES	ZZ.ZZ		
GALLEY AREA	ZZ.Z	SQ. FT.	
CLOSET AREA	ZZ.Z	SQ. FT.	
CABIN DIAMETER	ZZ.Z	IN.	***
BODY DIAMETER	ZZ.Z	IN.	***
NOSE SECTION LENGTH	ZZ.Z	FT.	
TAIL SECTION LENGTH	ZZ.Z	FT.	
CONST. DIA. LENGTH	ZZ.Z	FT.	
TOTAL FUSELAGE LENGTH	ZZ.Z	FT.	

*** Adjacent to CABIN DIAMETER and BODY DIAMETER will be printed the words:

TOURIST CLASS CRITICAL

or

FIRST CLASS CRITICAL

This will designate which class of service determined the body diameter.

6.1.3.2. Weights Data

First print G_{LF}, then print:

PROPULSION GROUP

$K_2W_{R/P}$, K_3W_{DS}, K_4W_{EL} K_5W_{EP}, K_6W_{LEI}

K_7W_{PEI}, $K_{21}W_{FS}$, ΔW_p, W_p

STRUCTURES GROUP

K_8W_W, K_9W_{HT}, $K_{10}W_{VT}$, $K_{11}W_B$, $K_{12}W_{LG}$

$K_{13}W_{LES}$, $K_{14}W_{PES}$, ΔW_{ST}, W_{ST}

FLIGHT CONTROLS GROUP

$K_{15}W_{CC}$, $K_{16}W_{UC}$, $K_{17}W_H$, $K_{18}W_{FW}$, $K_{19}W_{SAS}$

$K_{20}W_{TM}$, ΔW_{FC}, W_{FC}

WEIGHT EMPTY

WE

FIXED USEFUL LOAD

W_{FUL}

OPERATING WEIGHT EMPTY

OWE

PAYLOAD

W_{PL}

FUEL

$(W_f)_A$, W_{fW}

GROSS WEIGHT

W_G

6.1.3.3 Propulsion Data

The type of propulsion data to be printed is dependent upon the type of engines selected and certain input indicators.

6.1.3.3.1 Primary Engine Data

Print the following:

PRIMARY PROPULSION CYCLE NO.________________

XXXXX ENGINE

(XXXXX will be either TURBOFAN, TURBOJET, OR TURBOSHAFT)

XXX ENGINES (XXX will be the number of primary engines, N_P)

F*N = (If ENGIND = 1 or 2)

SHP* = (If ENGIND = 0 or 2)

After this data has been printed out, one of the following four statements should be printed:

1. ENGINE SIZED FOR TAKEOFF AT T/W =______, ______ PERCENT, __*__ POWER SETTING VERTICAL RATE OF CLIMB = _______FT/MIN, H = FT., TEMPERATURE = ________°F AND _______ ENGINES INOPERATIVE

*MAXIMUM, MILITARY, OR NORMAL

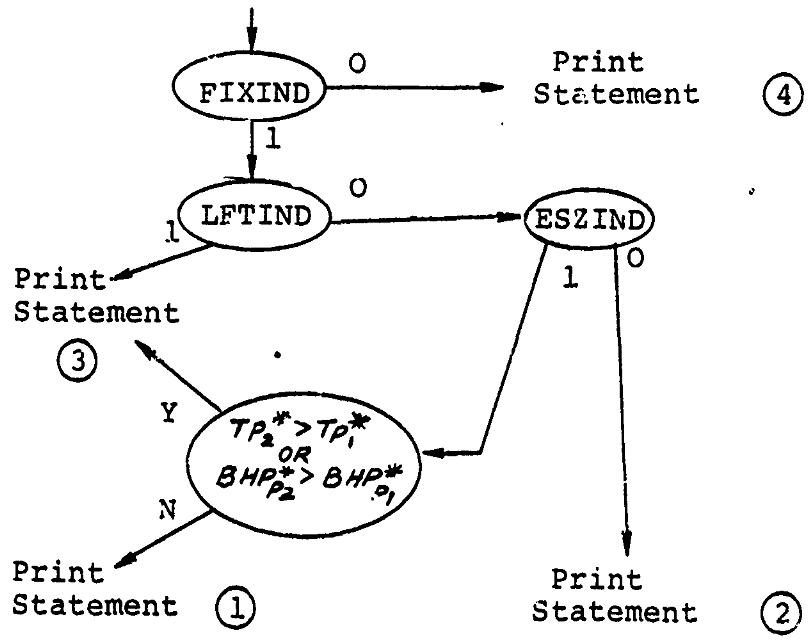
2. Print the same as 1, then print:

   NO CRUISE CONDITION SPECIFIED

3. ENGINE SIZED FOR CRUISE AT VC = KNOTS, HC = ______FT., TEMPERATURE = _________°F.

4. ENGINE SIZE WAS FIXED BY INPUT

The statement which will be printed out depends upon the following logic:



6.1.3.3.2 Lift Engine Data

If LFTIND = 0 print the following:

NO LIFT ENGINE CYCLE SELECTED

Otherwise (if LFTIND = 1) print the following:

LIFT ENGINE CYCLE NO. __________

XXXXX ENGINE

(XXXXX will be either LIFT FAN OR LIFT TURBOFAN)

XXX ENGINES IN YYY CLUSTERS (XXX will be the number of lift engines, N_L and YYY will be the number of clusters, N_c)

F*NL =

After this data has been printed out one of the following three statements should be printed:

1. ENGINE SIZED FOR TAKEOFF WITH T/W = _______,
   ______ PERCENT POWER
   AUGMENTED BY PRIMARY PROPULSION OF ______%.
   CRITICAL SIZING CONDITION IS ______ PRIMARY
   ENGINES INOPERATIVE.
2. ENGINE SIZED FOR TAKEOFF WITH T/W = _______,
   ______ PERCENT POWER
   AUGMENTED BY PRIMARY PROPULSION OF _______%.
   CRITICAL SIZING CONDITION IS ______ LIFT
   ENGINES INOPERATIVE.

3. ENGINE SIZE WAS FIXED BY INPUT.

6.1.3.4 Aerodynamics Data

The following data is printed:

f_e, S_{WET}, $\overline{C}_f$

If OPTIND = 1, this is followed by:

DRAG BREAKDOWN:

WING FE =

FUSELAGE FE =

VERTICAL TAIL FE =

HORIZONTAL TAIL FE =

PRIM. ENGINE NACELLE FE =

LIFT ENGINE NACELLE FE =

If DRGIND = 0, the following data is then printed:

a_1, a_2, a_3, a_4

This is followed by:

a_5, a_6, a_7

Then print the following:

OSWALD'S FACTOR =

THREE DIMENSIONAL LIFT COEFFICIENT SLOPE =

6.1.4 Mission Performance Data

Two types of output are possible. If the OPTIONAL PRINT INDICATOR is input as 0 a standard printout will occur. If the indicator is input as 1 a detailed printout will occur. This will include all data printed in the standard printout plus additional information.

6.1.4.1 Standard Printout

The mission performance data is printed out by segment in chronological sequence. Up to fifteen columns of data are printed out depending upon the segment. For all segments, the following information is printed:

t: time in hours

R: range in nautical miles

W_f: weight of fuel used in pounds

W: airplane weight in pounds

h: altitude in feet

TAS: the true airspeed in knots

T: the engine turbine temperature

ENGINE CODE: a code letter which designates the condition governing the engine performance:

P = power (or thrust) required

T = turbine temperature (engine rating)

W = fuel flow limit

N1 = gas generator shaft rpm limit

C = compressor ($N_I/\sqrt{\theta_1}$) limit

N2 = output shaft rpm limit

Q = torque limit

PETF or PEHF: the primary engine thrust fraction or horsepower fraction. This is the ratio of thrust or power being used at any altitude, Mach number condition to the maximum thrust, or power available at that condition.

In addition, the following data is printed out in different segments:

T/W: The thrust-weight ratio. (Printed out in takeoff, hover and landing.)

LETF: The lift engine thrust fraction. (Printed out in taxi and takeoff, hover and landing.)

EAS: The equivalent airspeed in knots. (Printed out in climb, cruise, descent, and loiter.)

MACH: The Mach number. (Printed out in climb, cruise, descent, and loiter.)

MACH DIV: The Mach number for drag divergence. (Printed out in climb, cruise, and descent.)

GAMMA: The flight path angle in degrees. (Printed out in climb and descent.)

THETA F: The fuselage attitude angle in degrees. (Printed out in climb and descent.)

R/C: Rate of climb in feet per minute. (Printed out in climb.)

NMPP: The specific range in nautical miles per pound. (Printed out in cruise.)

R/S: Rate of sink in feet per minute. (Printed out in descent.)

FUEL RATE: Time rate of fuel consumption in pounds per hour. (Printed out in loiter.)

ETAP PROP: Propeller efficiency. (Printed out in takeoff/hover/landing, cruise, and loiter.)

CT: Propeller thrust coefficient

CP: Propeller power coefficient

VTIP: Prop tip speed (feet/sec)

} Printed out in takeoff, hover, and landing

6.1.4.2 Detailed Printout

In addition to the data printed above, the following data will be printed in climb, cruise, descent, and loiter segments if the OPTIONAL PRINT indicator = 1:

CL: Lift coefficient

CD: Drag coefficient

L/D: Lift to drag ratio

LIFT: Total lift in pounds

DRAG: Total drag in pounds

FUEL FLOW: Pounds per hour of fuel consumption

BHP: Horsepower being used

THRUST: Pounds of engine or propeller thrust

CP: Propeller power coefficient

CT: Propeller thrust coefficient

J: Propeller advance ratio

VTIP: Tip speed of the propeller in feet per second

ETAP: Propeller efficiency

6.1.4.3 Headings

At the beginning of each segment, a printout will identify the segment data which follows. The following messages can be printed:

a. TAXI FOR ____HRS. AT GROUND IDLE ENGINE RATING

b. TAKEOFF, HOVER, OR LAND AT T/W = ____FOR____HRS.

or: TAKEOFF, HOVER, OR LAND AT PETF = _____,

LETF = _____FOR ____HRS.

c. CLIMB TO___FT. WITH MAX R/C AT___ENGINE RATING

CLIMB TO___FT. WITH CONSTANT EAS AT___ENGINE RATING

CLIMB TO___FT. WITH CONST. MACH NO. AT___ENGINE RATING

CLIMB TO___FT, WITH CONSTANT TAS AT___ENGINE RATING

CLIMB TO OPT. ALT. FOR NEXT CRUISE WITH MAX. R/C AT ___ENGINE RATING, MAXIMUM ALT.___FT.

CLIMB TO OPT. ALT. FOR NEXT CRUISE WITH CONSTANT EAS AT___ENGINE RATING, MAXIMUM ALT.___FT.

CLIMB TO OPT. ALT. FOR NEXT CRUISE WITH CONST. MACH NO. AT__ENGINE RATING, MAXIMUM ALT.__FT.

CLIMB TO OPT. ALT. FOR NEXT CRUISE WITH CONSTANT TAS AT___ENGINE RATING, MAXIMUM ALT.___FT.

d. CRUISE AT___ENGINE RATING

CRUISE AT___KNOTS TAS LIMITED BY___ENGINE RATING

CRUISE AT BEST RANGE SPEED WITH HEADWIND OF___KNOTS

CRUISE AT SPEED FOR 99 PERCENT BEST RANGE WITH HEADWIND OF___KNOTS

CRUISE AT BEST RANGE SPEED WITH HEADWIND OF___ KNOTS, CONSTANT W/DELTA = ___

e. DESCEND TO H=___FT AT MAX SPEED

DESCEND TO H=___FT, R=___NM AT MAX SPEED

DESCEND TO H=___FT AT FLIGHT IDLE ENGINE RATING

DESCEND TO H=___FT, R=___NM AT FLIGHT IDLE ENGINE RATING

DESCEND TO H=___FT AT CONSTANT EAS

DESCEND TO H=___FT, R=___NM AT CONSTANT EAS

DESCEND TO H=___FT AT CONSTANT MACH NO.

DESCEND TO H=___FT, R=___NM AT CONSTANT MACH NO.

f. LOITER FOR___HRS.

LOITER FOR___HRS. FOR RESERVE FUEL

g. CHANGE FUEL, ADD___LB

CHANGE FUEL, REMOVE___LB

h. CHANGE PAYLOAD, ADD___LB

CHANGE PAYLOAD, REMOVE___LB

i. TRANSFER ALTITUDE TO___FT

After the complete mission history has been printed, the following fuel summary will be printed:

MISSION FUEL REQUIRED =

RESERVE FUEL REQUIRED =

TOTAL FUEL REQUIRED =

6.1.5 General Performance

At the top of each general performance segment, the following data will be printed out:

GROSS WEIGHT =	______	LB	W/DELTA =	______	LB
ALTITUDE =	______	FT	DELTRTH =	______	
TEMPERATURE =	______	DEG.,F.	DELTA =	______	
			THETA =	______	

where W = aircraft weight
DELTA = δ = pressure ratio
THETA = θ = temperature ratio
DELTRTH = $\delta\sqrt{\theta}$

In addition to the above data, general performance mission data will also be printed out and consists of:

TAS: True Airspeed
CL: Wing Lift Coefficient
TOTAL FUEL FLOW: Primary and Lift Engine Fuel Flow
CD: Aircraft Drag Coefficient
L/D: Lift to Drag Ratio
THRUST TO WEIGHT: Total Thrust to Aircraft Weight
LIFT: Lift Produced by Wings and/or Engines
EAS: Estimated Airspeed
DRAG: Total Aircraft Drag
FUEL FLOW PRIM. ENG: PRIMARY FUEL FLOW IN LBS/HR
FUEL FLOW LIFT ENG: LIFT ENGINE FUEL FLOW IN LBS/HR
TURB. TEMP. (R): ENGINE TURBINE TEMPERATURE IN DEGREES R

$$J\text{: ADVANCE RATIO} = \frac{5.30615\,(\text{AIRCRAFT VELOCITY-KTS})}{V_{TIP_{OPERATING}}}$$

PETF OR PEHF: PRIMARY ENGINE THRUST OR HORSEPOWER FRACTION
LETF: LIFT ENGINE THRUST FRACTION
MACH: AIRCRAFT MACH NUMBER

$$CP\text{: POWER COEFFICIENT} = \frac{550\,(\text{HORSEPOWER})\,\pi^3}{(V_{TIP_{OPER}})^3\,(\text{DIAMETER})^2}$$

MACH DIV: MACH DIVERGENCE NUMBER

$$CT\text{: THRUST COEFFICIENT} = \frac{(\text{THRUST})\,\pi^2}{(V_{TIP_{OPER}})^2\,(\text{DIAMETER})}$$

$$\text{OR CT} = \frac{\text{CP(PROP EFFICIENCY)}}{\text{ADVANCE RATIO}}$$

SPEC. RANGE (NMPP): SPECIFIC RANGE = $\frac{\text{VELOCITY}}{\text{FUEL FLOW}}$ IN NAUTICAL MILES PER POUND

VTIP: PROPELLER OPERATING TIP SPEED IN FEET PER SECOND

BHP: ENGINE BRAKE HORSEPOWER

$$\left[\text{BHP}\right]_{T/0} = \frac{\left(\frac{\text{THRUST}}{\text{WEIGHT}}\right)^{3/2} \text{GW} \sqrt{\text{DISC LOADING}}}{550 \sqrt{2\rho}\ \eta_T\ \eta_P} + \Delta\text{SHP}_{\text{ACCESSORY}}$$

$$\left[\text{BHP}\right]_{CR} = \frac{\text{CD(WING AREA)}\ (1/2\ \rho\ V^2)\ V}{550\ \eta_T\ \eta_P} + \Delta\text{SHP}_{\text{ACCESSORY}}$$

NET THRUST: NET PRIMARY AND LIFT ENGINE THRUST

FM: FIGURE OF MERIT = $\frac{0.798(\text{CT}^{1.5})}{\text{CP}}$

ETAP PROP: PROPELLER EFFICIENCY IN CRUISE FLIGHT

Main transmission torque limit messages will be printed out after the performance calculation for V_{MAX}. One of the following messages will be printed depending on the options chosen by the user:

- MAIN TRANSMISSION TORQUE LIMIT NOT APPLIED
- MAIN TRANSMISSION TORQUE LIMIT NOT EXCEEDED AT THESE FLIGHT CONDITIONS
- MAIN TRANSMISSION TORQUE LIMIT (ALL ENGINES OPERATING) OCCURS AT

V	=	_______	KTAS
MAIN ROTOR VTIP	=	_______	FT/SEC
MAIN ROTOR RPM	=	_______	
POWER	=	_______	SHP
TORQUE	=	_______	FT-LB

A summary of the aircraft's velocity as a function of power, and corresponding specific range and engine code is printed out after the transmission torque limit message. The following is an example:

```
**V(MAX PWR)          = ____KTAS  SPEC. RANGE = ____NM/LB  *
**V(MIL PWR)          = ____KTAS  SPEC. RANGE = ____NM/LB  *
**V(NRP)              = ____KTAS  SPEC. RANGE = ____NM/LB  *
  V(BEST RANGE)       = ____KTAS  SPEC. RANGE = ____NM/LB  *
  V(99 PERCENT BR)    = ____KTAS  SPEC. RANGE = ____NM/LB  *
  V(BFST ENDURANCE)   = ____KTAS   FUEL FLOW  = ____LB/HR  *
```

*SIGNIFIES ENGINE OPERATING CODE

**In the event that cruise is not possible at any one of these power conditions the following message will be printed:

INSUFFICIENT POWER AVAILABLE FOR CRUISE AT _________ ENGINE RATING

Where MAXIMUM, MILITARY, or NORMAL ENGINE RATING will be printed.

6.2 LIST OF DIAGNOSTIC ERROR PRINTOUTS

6.2.1 Errors Affecting Main Control Loop

6.2.1.1 *** ERROR THE USER REQUESTED PRIMARY ENGINE CYCLE NO. XXX BUT THE INPUT DECK WAS SET UP TO USE NO. YYY

The operator used an engine cycle whose identification number differed from that requested by the user (LOC. 0201).

REMEDY: Use correct engine cycle.

6.2.1.2 *** ERROR THE USER REQUESTED LIFT ENGINE CYCLE NO. XXX BUT THE INPUT DECK WAS SET UP TO USE NO. YYY

The operator used an engine cycle whose identification number differed from that requested by the user (LOC. 0218).

REMEDY: Use correct engine cycle.

6.2.1.3 *** ERROR THE USER REQUESTED PROP TABLE NO. XXX BUT THE INPUT DECK WAS SET UP TO USE NO. YYY

The operator used a propeller table whose identification number differed from that requested by the user (LOC. 0256).

REMEDY: Use correct propeller table.

6.2.1.4 ERROR *** THE FIRST SEGMENT INDICATOR OF A MISSION CANNOT BE 0., 100., or 5. (DESIND = 1, 3) SEE USERS MANUAL

a. Segment indicators 0., 100., represent the end of a mission calculation and the end of a particular case respectively. Either of these indicators at the beginning of a set would be meaningless.

b. Descent options 1 and 3 must be preceded by a cruise segment.

REMEDY: Rewrite segment indicator list (Starts at LOC. 0027)

6.2.1.5 ERROR *** DESCENT 1 or 3 MUST BE PRECEDED BY A CRUISE

See 6.2.1.4 (b)

REMEDY: Redefine the mission with a different sequence of segment indicators.

6.2.1.6 *** ERROR FUEL AVAILABLE AND FUEL REQUIRED DO NOT CONVERGE AT A POSITIVE GROSS WEIGHT

This indicates that the performance requirements are too stringent or that the weight is excessive. This may be due to pessimistic weight input constants or drag characteristics, or it may be that the mission required cannot be flown by any airplane sized by VASCOMP. It may require some novel design considerations.

6.2.1.7 *** ERROR WFR WEIGHT OF FUEL REQUIRED IS LESS THAN OR EQUAL TO ZERO.

This message can occur only if negative values of reserve fuel factors are input (LOC. 0024, 5, 6)

REMEDY: Correct reserve fuel factors.

6.2.1.8 ********** THIS AIRCRAFT HAS NOT CONVERGED AFTER 25 ATTEMPTS. THE WEIGHT OF FUEL AVAILABLE (WFA) = XXX THE WEIGHT OF FUEL REQUIRED (WFR) = YYY (WFA) MUST BE WITHIN ZZZ OF (WFR) FOR THE AIRCRAFT TO CONVERGE. THIS TOLERANCE IS SET IN THE MAIN PROGRAM UNDER THE NAME TOL.

If this message occurs it is probable that the mission required cannot be flown by an aircraft of the type specified by the input data. A possible cause may be unrealistic input values of the reserve fuel factors or weights constants.

6.2.1.9 *** ERROR - NO TITLE CARD AFTER SEVEN CARD, COLUMNS 1 THRU 6 ON TITLE CARD MUST BE BLANK OR THERE WAS A 6 IN COLUMN 5 OF AN INPUT CARD

This message is printed if the input card deck is improperly set up. No output is generated.

REMEDY: Examine input deck for errors indicated in message and correct them.

6.2.1.10 ERROR, THE NUMBER OF ITERATIONS IN THE SIZTR ROUTINE EXCEEDED 25, CASE TERMINATED.

This message will be printed if the SIZE TRENDS subroutine is unable to determine the engine size to satisfy the takeoff conditions specified in LOC. 0207 through 0212. This is due to the non-linear scaling of the engine that results when Reynolds Number effects are included.

REMEDY: Correct the table of Reynolds Number correction factor on the Non-standard Engine Cycle Data Input Sheet (LOC. 1206 through 1257) or select a new engine cycle.

6.2.1.11 ERROR, THE NUMBER OF ITERATIONS IN THE ENGINE SIZING ROUTINE EXCEEDED 25, CASE TERMINATED

This message will be printed if the ENGINE SIZING subroutine is unable to determine the engine size to satisfy the engine sizing conditions (takeoff and/or cruise) as specified in LOC. 0207 through 0217. This may be due to an error in the Reynolds Number correction factor table (LOC. 1206 through 1234).

REMEDY: Correct the Reynolds Number correction factor table or select a new engine cycle.

6.2.1.12 (a) J OR M DOES NOT CONVERGE IN 25 ITERATIONS - SUBROUTINE POWER
(b) CT OR F_N DOES NOT CONVERGE IN 25 ITERATIONS - SUBROUTINE POWER

These messages are printed if a match cannot be found between propeller/fan thrust and available power. Message (a) is printed in forward flight calculations and (b) is printed in static (Take-off, hover or landing) calculations.

REMEDY: Increase engine power, reduce drag or modify propeller related inputs.

6.2.1.13 GAMMA FAILED TO CONVERGE IN 20 ITERATIONS - SUBROUTINE THRUST

This message will be printed if the propeller thrust calculation routine cannot converge on a thrust and efficiency that will match the required thrust. Such an error is unlikely and would occur only in cases involving extreme thrust requirements.

REMEDY: Review input data that specifies propeller requirements.

6.2.1.14 ***ERROR*** TORQUE LIMIT OPTION USED NOT APPLICABLE TO CONVERTIBLE ENGINES. PROGRAM APPLIED XMSN LIMIT AS SPECIFIED FRACTION OF INSTALLED TAKEOFF POWER.

This message is printed if ENGIND = 2.0 and XMSNIND = 1.0. Converticle engines can only be torque limited in the hover condition.

REMEDY: Change XMSIND (LOC 0257) TO EQUAL 0.

6.2.1.15 ***WARNING*** CONVERTIBLE ENGINE SIZED FOR CRUISE. XMSN TORQUE LIMIT OPTION INPUT IGNORED.

This message is printed if the convertible engine was sized for the cruise installed power which was more critical than the hover condition.

REMEDY: Program applies correction by bypassing torque limit option.

6.2.2 Errors Related to Tabulated Inputs

6.2.2.1 Two Dimensional Tables

ERROR THE FOLLOWING VALUES MAY NOT BE ACCURATE. THE INDEPENDENT VARIABLE WAS OUT OF RANGE OF THE TABLE. THESE VALUES WERE CALCULATED USING THE YYYYY VALUE GIVEN IN THE TABLE. THIS ERROR IS IN THE XXXXX TABLE.

This message occurs whenever the computer is required to look up a value in a table of input quantities at a calculated value of the independent variable which lies outside the range of the input values of the independent variable.

If the calculated independent variable is below the lowest value of the input table, the computer uses the first value in the table and YYYYY in the message reads FIRST. If it lies above the highest value, the last value in the table is used and YYYYY becomes LAST.

XXXXX in the last line of this message identifies the table in which the error occurs. The tables in which this could occur are shown below. The third column indicates the part of the message which is shown above as XXXXX.

INDEPENDENT VARIABLE	DEPENDENT VARIABLE	XXXXX
M	η_{p4}	M, ETAP4
C_L	$C_{D_{Wi}}$	CL, CDWI
h	θ	H-THETA
$(F_N/\delta\, F_N^*)_L$	T/θ	LIFT ENGINE POWER
$(\dot{W}/\delta \sqrt{\theta} F_N^*)_L$	T/θ	LIFT ENGINE FUEL FLOW
$N_I/\sqrt{\theta} N_I^*$	T/θ	LIFT ENGINE NSUB1
$N_{II}/\sqrt{\theta} N_{II}$	T/θ	LIFT ENGINE NSUB2
N_{II}/N_{IIOPT}	K_{PN}	NSUB2 CORRECTION FACTOR
$(N_I/N_I^*)(D/\nu_1)$	K_{PR}	REYNOLDS NUMBER
Q/Q^*	T/θ	TORQUE LIMIT LOOK UP
$(SHP/\delta \sqrt{\theta} SHP^*)_{REQ}$	T/θ	POWER REQUIRED LOOK UP
C_L	γ	PROPELLER EQUIVALENT LIFT DRAG POLAR†
C_{Ti}	C_p	CTI - CP

† Strictly speaking, this table is not an input. The table is calculated in the main control loop using BLOCK DATA and the input value of INTEGRATED LIFT COEFFICIENT (LOC. 0230). The error message indicates that the value of C_L used was above the maximum value in the table. This will occur only if an unusual combination of high power coefficient and low propeller activity factor exists. In such a case the user should change the propeller input parameters to obtain a propeller that more closely matches the performance requirements.

6.2.2.2 Three Dimensional Tables

ERROR THE FOLLOWING VALUES MAY NOT BE ACCURATE. THE AAA INDEPENDENT VARIABLE IS OUT OF RANGE OF THE TABLE. THE PROGRAM USED THE BBB VALUE IN TABLE TO CALCULATE. THIS ERROR IS IN THE XXXX PART OF THE YYYYY TABLE.

This message is printed whenever one of the calculated independent variables lies outside the range of the independent variables defining the table input by the user.

The XXXX and YYYYY parts of the message respectively name the independent variable and the table in which the error occurred. AAA stands for FIRST or SECOND, BBB stands for FIRST or LAST.

The tables in which this error could arise are shown below. The items in parentheses show the variables as they appear in the error message.

DEPENDENT VARIABLE	INDEPENDENT VARIABLES (XXXX)	NAME OF TABLE (YYYYY)
ΔC_{DM}	C_L (CL), M	COMPRESSIBILITY DRAG
$F_N/\delta F_N^*$	T/θ (T), M	REFERRED THRUST
$SHP/\delta\sqrt{\theta}SHP^*$	T/θ (T), M	REFERRED POWER
$\dot{W}/\delta\sqrt{\theta}SHP^*$ or $\dot{W}/\delta\sqrt{\theta}F_N^*$	T/θ (T), M	REFERRED FUEL FLOW
$N_I/\sqrt{\theta}N_I^*$	T/θ (T), M	REFERRED NSUB1
$N_{II}/\sqrt{\theta}N_{II}^*$	T/θ (T), M	REFERRED NSUB2
C_T	C_P (CP), M	PROPELLER POWER COEFFICIENT

REMEDY: Rewrite the input table so that the independent variable that was previously out of range will fall into the range of the new table.

6.2.2.3 MACH NUMBER OUT OF RANGE FOR DRAG CALCULATIONS SET DRGIND = 1

This message indicates that the current value of M is outside the range of Mach Number in which a calculation of ΔC_{DM} can be performed by the program.

REMEDY: Set DRGIND = 1. (LOC. 0003), input a table of ΔC_{DM} versus C_L, M in the Aerodynamics Information Input Sheet.

6.2.3 Errors Occurring In Performance Calculations

6.2.3.1 a. CAUTION ** PEHF IS GREATER THAN 1.

b. CAUTION ** PETF IS GREATER THAN 1.

These messages indicate a condition for which greater than 100 percent of maximum power or thrust was required during takeoff, hover, or landing.

REMEDY: Increase engine power available or decrease required thrust-weight for hover.

6.2.3.2 CAUTION, STATIC THRUST NOT INCLUDED IN PROP DECK, LOWEST ADVANCE RATIO USED

This message is printed during execution of the TAKEOFF, HOVER or LANDING SUBROUTINE if the propeller input table does not include static performance data (J=0). The table should include static performance data if accurate answers are required for hover performance.

REMEDY: Rewrite the propeller table to include static performance data.

6.2.3.3 TAKEOFF AND LANDING OPTION NO. 2 IS NOT PERMITTED IF ENGIND = 0, 2 OR LFTIND = 0

TOLIND (LOC. 0601 through 0610) = 2. requires that equal amounts of power are drawn from primary and lift-engines. If ENGIND (LOC. 0011) = 0. or 2., or if LFTIND (LOC. 0013) = 0., no lift engines are specified so execution of the program calculation is terminated.

REMEDY: Specify Lift Engine Cycle and LFTIND if required or change TOLIND array to eliminate 2.'s in LOC. 0601 through 0610.

6.2.3.4 ERROR * INSUFFICIENT POWER AVAILABLE FOR CLIMB

The message is printed if the engine thrust or power input by the user is insufficient to allow the aircraft to climb.

REMEDY: (a) Increase the engine power or thrust, whichever is appropriate, or (b) inspect the inputs which determine C_D and adjust them if they appear to give a grossly overrated value of C_D.

6.2.3.5 ERROR * INSUFFICIENT POWER AVAILABLE FOR CRUISE AT V GREATER THAN 150 KTS

This message will be printed if the thrust or power available at the required altitude is less than the minimum thrust or power required for steady level flight, that is, if the aircraft is above its absolute ceiling.

REMEDY: If OPTIND = 1, check to find if one of the cruise segments of the mission makes a demand inconsistent with the engine sizing criteria (LOC. 0213 through 0217). If OPTIND = 2 or if FIXIND = 0, it may be that engine power or thrust is unreasonably low or the drag excessive. Check the inputs in LOC. 0202 or 0203 and those on AIRCRAFT AERODYNAMICS INFORMATION input sheet.

6.2.3.6 ERROR ****** INSUFFICIENT POWER AVAILABLE FOR CRUISE AT DESIRED SPEED

This message will be printed during cruise if CRSIND = 2 (cruise at specified true airspeed) and insufficient power is available to maintain steady level flight at the desired speed. The remaining cruise calculations will be at constant power setting.

REMEDY: Increase engine power, decrease drag level, or decrease required cruise speed.

6.2.3.7 CAUTION SPEED LIMITED BY POWER/THRUST AVAILABLE AT SPECIFIED POWER SETTING

This message will be printed when power or thrust available is insufficient to allow the aircraft to cruise at speed for 99% best range as specified by selecting CRSIND = 4. or 6. (LOC. 0801 through 0810)

6.2.3.8 ERROR INSUFFICIENT POWER AVAILABLE FOR CRUISE AT V GREATER THAN 100 KTS

This message will be printed during cruise if CRSIND = 3, 4, 5 or 6 and insufficient thrust or power is available to maintain steady level flight at speeds greater than 100 knots TAS.

REMEDY: Increase engine power or reduce drag level.

6.2.3.9 DESCENT CONDITION IMPOSSIBLE R/S IS LESS THAN OR EQUAL TO 0.

The reason for this printout is that the flight path angle necessary to maintain the required body inclination has become positive.

REMEDY: Make the quantity ($\theta_{min} - \alpha LO + i_w$) more negative (See LOC. 0931 through 0940, 0332, and 0103).

6.2.3.10 DESCENT CONDITION IMPOSSIBLE DESIRED FLIGHT PATH IS TOO SHALLOW

This message will be printed out during descent at constant EAS or constant Mach number (DESIND = 5, 6, 7, 8). There are two possible sources for this error message:

a. The terminal range with DESIND = 5,7 is at such a great distance from the initial condition of descent that an extremely shallow flight path is required. This source of error is unlikely since it implies that insufficient power is available for cruise.

b. The required flight path angle is extremely shallow due to the restriction on minimum body attitude angle. Insufficient power is available to maintain flight at the required flight path angle.

REMEDY: Check θ_{min} (LOC. 0931 through 0940), R_{max} (LOC. 0961 through 0970), and power available.

6.2.3.11 **ERROR*** THE RANGE NECESSARY TO DESCEND IS GREATER THAN THE RANGE OF THE TABLE CALCULATED IN CRUISE. THIS MAY BE DUE TO A DELTA R IN CRUISE WHICH IS TOO SMALL.

The computer saves the last ten points of the cruise from R_{max} backward so that an iteration can be carried out to find the correct point to start the descent when DESIND = 1,3. This error message is printed if the stored values do not cover a sufficient range back from R_{max}. Either ΔR is too small or the angle of descent is very small.

REMEDY: Check ΔR (LOC. 0831 through 0840), θ_{min} (LOC. 0931 through 0940), α_{LO} (LOC. 0332) and i_w (LOC. 0103).

6.2.3.12 INSUFFICIENT POWER FOR STEADY LEVEL FLIGHT

This message appears during the loiter segment calculations.

REMEDY: Check power available and drag level.

6.2.3.13 THIS ERROR IS IN THE XXXX PART OF THE FIGURE OF MERIT TABLE.

XXXX IS EITHER CT/SIGMA OR MACH No.

This error message refers to the table look-up of figure of merit, FM, found in table locations 2351 to 2432. FM is a function of CT/SIGMA and MACH NUMBER.

REMEDY: Check to make sure that the number of table inputs for CT/SIGMA and MACH NO. matches the No. of Values in table input locations 2351 and 2362, respectively.

6.2.3.14 THE NUMBER OF ITERATIONS FOR TRANSMISSION SIZING FOR FIXED SIZE ENGINES EXCEEDED 25, SUBROUTINE MAIN, CASE TERMINATED

This error message is printed out only if FIXIND = 0.0 and XMSNIND = 1.0. This is due to the inability of the program to converge at a specified cruise power required, which depends on the η_{PIND} chosen.

REMEDY: Possible choices are to reduce the power

requirements, change η_{PIND} to 0.0, or set XMSNIND = 0.0.

6.2.3.15 ***ERROR*** TORQUE LIMIT OPTION USED NOT APPLICABLE TO CONVERTIBLE ENGINES. PROGRAM APPLIED XMSN LIMIT AS SPECIFIED FRACTION OF INSTALLED TAKEOFF POWER.

This message appears during engine sizing and is generated when ENGIND = 2.0, and XMSNIND = 1.0.

REMEDY: Set XMSNIND = 0.0.

6.2.3.16 ***WARNING*** CONVERTIBLE ENGINE SIZED FOR CRUISE. XMSN TORQUE LIMIT OPTION IGNORED

This message is printed during engine sizing if ENGIND = 2.0, XMSNIND = 0.0, and ESZIND = 1.0 where the engine is sized for cruise.

REMEDY: If it is desired to size transmission at specified power, the user should minimize cruise requirements.

7.0 PROGRAM USAGE

7.1 COMMENTS ON PROGRAM USAGE

Following are a list of rules and suggestions for using the program:

7.1.1 Rules

7.1.1.1 Do not use descent options 1 or 3 unless preceded by a cruise.

7.1.1.2 Do not input a turboshaft engine cycle (cycles 1-9) if LFTIND = 1.

7.1.1.3 Do not input WDMIND = 1 or 2 if ENGIND = 1.

7.1.1.4 If OPTIND = 2, the airplane profile drag coefficient should be divided into two terms. The wing profile drag coefficient is input to the table of C_{DWi} versus C_L, and all other component contributions are input by means of the term ΔC_D (LOC. 0305). The terms $C_{D_{VTi}}$, $C_{D_{HTi}}$, $C_{D_{Ni}}$, $C_{D_{LNi}}$, and Δf_e and the factors

K_{LN}, K_N, K_F, K_{VT}, and K_{HT}, are not used in OPTIND = 2.

If the option indicator is 1, all terms and factors may be used. However, if it is desired to minimize input, the technique described above may also be used when OPTIND = 1. The major disadvantage is a slight reduction in accuracy since the term ΔC_D is not modified by the Reynolds' number functions and therefore would not reflect aircraft growth.

7.1.1.5 If cruise is followed by descent with DESIND = 1 or 3, the cruise step size (LOC. 0831 - 0840) should not be less than 10 to 15 nautical miles. This is necessitated by the fact that a table of cruise conditions is compiled during cruise to use in the determination of the starting point for descent. This table consists of 10 points. The cruise step size therefore must be sufficiently large to ensure that the total of nine steps in range is greater than the range required for the following descent. A cruise step size which is too small will lead to termination of the case with the printout:

7.1.1.6 If η_pIND = 1.0, the first value of advance ratio J should correspond to at most the forward flight stall speed, and should never equal zero.

*** ERROR *** THE RANGE NECESSARY TO DESCEND IS GREATER THAN THE RANGE OF THE TABLE CALCULATED IN CRUISE. THIS MAY BE DUE TO A DELTA R IN CRUISE WHICH IS TOO SMALL.

7.1.1.7 At present do not use SGTIND = 7 with OPTIND = 1 unless a sufficiently large ΔW_f is input to completely refuel the aircraft. This rule will be eliminated by future modifications to the program. For the present, missions employing change of fuel can be analyzed by running separate cases, a new case each time the fuel is changed. The aircraft can be separately sized for each case and compared manually.

7.1.1.8 The value for payload which is input (LOC. 0403) should be the payload at initial takeoff.

7.1.1.9 To calculate a conventional climb path, input Δn_{CLIMB} into LOC. 0791 - 0800. The airplane lift to weight ratio will be correctly calculated by the program as $L/W = \cos \gamma$. To calculate energy-maneuverability data, input $\Delta n_{CLIMB} \neq 0$. The airplane lift to weight ratio will be calculated as $L/W = 1 + \Delta n_{CLIMB}$. In order to calculate energy maneuverability at L/W = 1, input Δn_{CLIMB} as a small non-zero number (for example 0.001).

7.1.1.10 Do not use transmission sizing option XMSNIND = 1.0 when employing convertible engines (LOC 0011 = 2.0), as convertible engines do not use a transmission for cruise flight.

7.1.2 Suggestions

7.1.2.1 If nonstandard atmosphere is required only for constant altitude segments, such as loiter, cruise, and takeoff, the table of temperature ratio versus altitude need not be filled in. The nonstandard atmosphere may be obtained by use of ATMIND = 1.

7.1.2.2 If it is desired to run OPTIND = 2 for an aircraft which has previously been sized in a separate case, the drag will be represented correctly if the output values of a_5 and a_6 from the sizing case are input for the OPTIND = 2 case to ΔC_D (LOC. 0305) and K_W (LOC. 0312) respectively, and if the C_{DWi} table is filled in identically to the sizing case.

7.1.2.3 To represent engines which are buried in the fuselage, input K_N (LOC. 0313) or K_{LN} (LOC. 0311) or both as zero. The component drag will then be zero and calculation of engine dimensions will be bypassed.

7.1.2.4 The order in which segments 7 and 8 are used is important due to the fact that the program will not permit the aircraft weight, during a change of weight segment, to exceed gross weight. As an example, to simulate adding 200 pounds of payload, followed by refueling back to gross weight limits, the eighth performance segment (change of payload weight) should be entered first with an input of ΔW_{PL} (LOC. 1131 through 1140) of 200. Then, the change of fuel weight segment can be entered with a large number input for the ΔW_f quantity.

7.1.2.5 The weights factors K_2 through K_{21} (LOC. 0410, 0415, 0422-0439, 0459-0465) have a nominal value of 1.0 assigned to them by the program. These factors need not be input unless a nonunity value is desired. Similarly, the incremental group weights, ΔW_{FC} (LOC. 0417), ΔW_P (LOC. 0418), and ΔW_{ST} (LOC. 0419), are nominally zero and need not be input unless a nonzero value is desired. The reserve fuel factors K_1 (LOC. 0024) and δW_f (LOC. 0025) are nominally unity and zero respectively. The fuel flow multiplier K_{FF} (LOC. 0026) is nominally 1.0.

7.1.2.6 A cruise may be run with a headwind for cruise options 3 through 6 by input of the headwind in knots in locations 0811 through 0820. For cruise option 2 (specified constant true airspeed), the user can simulate cruise with a headwind by inputting an "equivalent" value for R_{max} (loc. 0851 - 0860), obtained by adjusting the true ground range desired by the ratio airspeed ÷ ground speed. The program output values for range must then be readjusted by the inverse of this ratio to obtain the correct ground range.

7.1.2.7 When a vertical rate of climb at takeoff is warranted for either engine sizing or performance calculations it is suggested that the constant $K_{R/C}$,LOC (0262), be input as follows:

If ENGIND = 0	$K_{R/C} = 1.5 - 2.0$
If ENGIND = 1	$K_{R/C}$ NOT APPLICABLE
If ENGIND = 2	$K_{R/C} = 1.0 - 1.4$

7.1.2.8 Consider an aircraft configured with turbofan/jet primary engines, and lift engines. If takeoff with a specified vertical rate of climb is warranted solely from the lift engines, it is suggested the user inputs a T/W that would correspond to the additional thrust above hover necessary to achieve the specified vertical rate of climb.

7.2 DISCUSSION OF PROGRAM TOLERANCES

The tolerances tabulated below represent the accuracy required of iterated values calculated at certain points in the program. Whenever the values of the quantities named in the table below become less than the value quoted, the iterating calculation is terminated.

TABLE 7-1
PROGRAM TOLERANCES

SYMBOL	VALUE	VARIABLE BEING CALCULATED	SITUATION IN PROGRAM	FUNCTION OF TOLERANCE
TOL	.01	W_G, Gross Weight	Main Control Loop	When the quantity [illegible] TOL the fuel required and available are considered to be sufficiently close and the sizing calculation is terminated.
$\Delta\gamma$	.1°	γ, Flight Path Angle	Climb & Descent Subroutines	Determines flight path angle to within .1°
ΔBHP	10.HP	BHP_R Power Required	Cruise	The cruise speed is set when BHP_R is within 10 HP of BHP_A
ΔT	10.LB	T_R Thrust Required	Subroutine	The cruise speed is set when T_R is within 10 lb. of T_A
ΔB	.01	$\frac{B_1 - B_2}{B_2}$	CRSIND = 1	$\frac{B_1 - B_2}{B_2}$ is used to adjust ΔV to expedite computation. If $\frac{B_1 - B_2}{B_2}$ becomes less than ΔB, BHP_R always exceeds BHP_A
ΔT_1	.01	$\frac{T_1 - T_2}{T_2}$		$\frac{T_1 - T_2}{T_2}$ is used to adjust ΔV to expedite computation. If $\frac{T_1 - T_2}{T_2}$ becomes less than ΔT_1, T_R always exceeds T_A
R_{TOL}	5.n.m.	R, Range	Descent Subroutine	If the range at the end of descent is within R_{TOL} n.m. of R_{max} the calculation terminates.

7.3 SAMPLE CASES

To illustrate the use of the program, three sample cases have been run and the output included here.

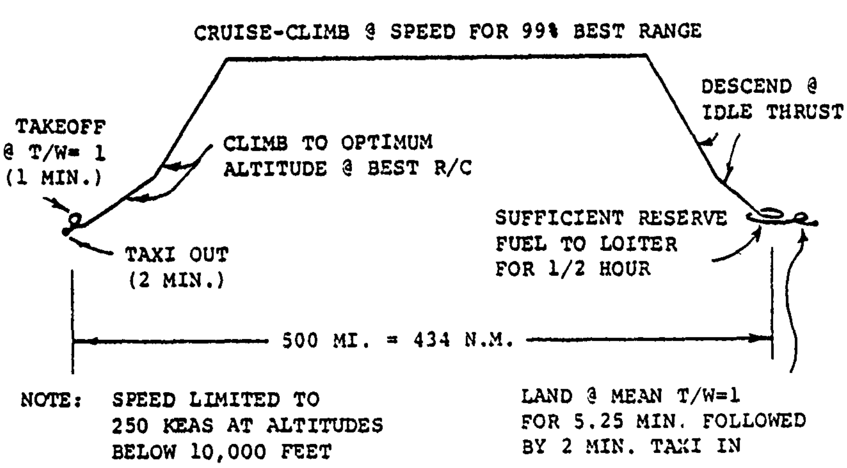
The first case is for a 60-passenger commercial lift fan VTOL aircraft similar to that shown in NASA CR-743. This case illustrates the use of dual propulsion (lift and primary), the sizing of a fuselage for specified passenger requirements and the automatic observance of speed restrictions at altitudes below 10,000 feet. The engines are sized to meet specified takeoff and cruise requirements. Runs 2 and 3 illustrate the use of standard printout and weights data, respectively.

The second case is for a military high-performance COIN turboprop. It illustrates the use of the automatic propeller performance subroutine, the study of a mission which is partly at optimum altitude and partly at specified altitude, and the determination of energy-maneuverability performance. The engine size is fixed for this case, but the transmission is sized for specified fraction of installed power in Run 1, and for a specified fraction of either hover or cruise power required (chooses the most critical condition).

The third case calculates sizing and performance data for a tilt-rotor aircraft. It illustrates the use of the general performance subroutine, figure of merit hover map, and engine sizing for; specified power fraction, vertical rate of climb, and accessory horsepower.

7.3.1 Lift Fan VTOL Aircraft

All inputs are discussed for this case. A complete copy of the program printout is shown following the description of the input. The design mission profile is shown below:



VASCOMP II - DESCRIPTION OF SAMPLE CASE 1

Run 1

General Information Sheet

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS	
OPTIND	0001	1.0	Sizing run	
TNIRPK	0002	1.0	Print indicator-optional print	
DRGIND	0003	0.0	Program calculates compressibility drag	
OSWIND	0004	1.0	Program calculates induced drag factor	
FDMIND	0006	2.0	Size fuselage for passenger requirements	
WDMIND	0007	0.0	Wing not dependent on propeller size	
HTIND	0008	1.0	Input tail volume coefficients	
VTIND	0009	1.0		
FIXIND	0010	1.0	Program sizes engines	
ENGIND	0011	1.0	Turbo fan primary engines	
WG_o	0014	70000.	1st guess at design gross weight	
h_o	0015	0.	Start altitude	Normally 0. except for partial mission analysis
R_o	0016	0.	Starting range	
t_o	0017	0.	Starting time	
HOPTIN	0018	1.0	Cruise desired at optimum altitude	
VLMIND	0019	1.0	Airspeed limited to 250 knots EAS at altitude of 10,000 ft or less	
M_{mo}	0020	0.83	Maximum operating mach number	
V_{mo}	0021	400	Maximum operating EAS knots	
V_{DIVE}	0022	450	Design dive speed	

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS	
M_{LF}	0023	2.5	Maneuver load factor	
K_1	0024	1.0	Factor on mission fuel burned to give reserve fuel, i.e. 1.1 would give 10% reserve	
SW_F	0025	0.	Fixed fuel increment for reserves or other use	
K_{FF}	0026	1.0	Use nominal engine fuel	
SGTIND	0027	1.	TAXI	
	0028	2.	TAKEOFF	
	0029	3.	CLIMB	
	0030	4.	CRUISE	SEQUENCE
	0031	5.	DESCEND	OR
	0032	60.	LOITER (Reserve fuel in this case)	DESIGN MISSION
	0033	2.	APPROACH AND LAND	
	0034	1.	TAXI	
	0035	100.	END OF CASE	

Aircraft Dimensional Sheet

AR	0101	3.2	Wing aspect ratio
i_W	0103	2.0	Wing incidence angle to fuselage horizontal datum (degrees)
$(L/_C)_R$	0104	.145	Root thickness-chord ratio
$(L/_C)_T$	0105	.1	Tip thickness-chord ratio
$W_G/_S$	0106	75.	Wing loading at design gross weight
$\Lambda c/4$	0107	35.	Quarter chord mean sweep angle, degrees
λ	0108	.23	Taper ratio (tip chord/root chord)
AR_{HT}	0109	3.3	Horizontal tail aspect ratio
a_H	0110	0.	Vertical position of horizontal tail on vertical tail, spans above vertical tail root chord. Valve is 0. on or below root chord, 1.0 for "T" tail

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
l_{TH}	0111	36.	Horizontal tail arm, FT
(t/c)HT	0112	.1	Horizontal tail mean thickness/ chord ratio
$\bar{V}_H$	0113	.6	Horizontal tail volume coefficient
λ_H	0114	.45	Horizontal tail taper ratio
$\Delta S_{WET}/S_W$	0120	0.	Incremert in wetted are a for landing gear or other protusions
(l/d)nose	0123	1.85	Fineness ratio of nose
(l/d)tail	0124	2.5	Fineness ratio of tail
l_{RW}	0126	0.	Length of ramp well or other strengthened fuselage portion (e.g., rear engine attachments). Used to compute fuselage weight penalty.
AR_{VT}	0129	1.5	Vertical tail aspect ratio
l_{TV}	0130	32.5	Vertical tail arm
(t/c)VT	0131	.1	Vertical tail thickness/chord ratio
$\bar{V}_v$	0132	.1	Vertical tail volume ratio
λ_v	0133	.45	Vertical tail taper ratio
Y_{mg}	0135	0.0	Spanwise distance of landing gear from mean spanwise distance
Y_p	0136	.48	of cruise engine from wing root in semispans. Used in wing relief term.
Y_L	0137	0.	Mean spanwise distance of lift propulsion system from wing root in semispans. Taken as 0. here since fans are inboard on the wing and gas generator, etc. are in the fuselage.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
ε	0138	-2.	Length of lift engine nacelle over and above engine diameters (see figure 2-1). This would not be used if K_{LW} (LOC. 0311) were 0 because the lift nacelle dimension calculation would be bypassed (see figure 4-12). However, we wanted the fan diameter to be printed out in the lift engine nacelle mean diameter location. Therefore ε was set to -2. to give the wetted area of the nonexsistent lift nacelles $S_W = 2\ \bar{d}_{LN}\ (N_L + \varepsilon N_C) l_{LM}$ as zero, and therefore give 0 nacelle drag, but allow $d = \frac{(T_L^*)^{1/2}}{N_L}$ to be printed out. ξ_1 has been chosen in the engine library information to make $\bar{d}_{LN}$ equal to the fan diameter.
Z_1	0139	.0334	Primary engine sizing constants
Z_2	0140	0.	
Z_3	0141	.1105	

Passenger Data Required For Fuselage Sizing

Gallery Indicator	0151	0.	The program will use a trend equation to determine gally size
No. of Passengers	0153	60.	
Seats Abreast	0154	5.	Data required for determining fuselage size this aircraft has a single class service. The data was input as first information, and the tourist data was zeroed out.
No. of Aisles	0155	1.	
Unit Seat Width	0156	22.	
Seat Pitch	0157	36.	
Aisle Width	0158	18.	

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
Lavatory Indicator	0159	0.	The program will use a trend equation to determine the number of lavatories
No. of Passengers	0161	0.	
Seats Abreast	0162	0.	Tourist class inputs zeroed, because aircraft is single service, and necessary information was input as first class information
No. of Aisles	0163	0.	
Unit Seat Width	0164	0.	
Seat Pitch	0165	0.	
Aisle Width	0166	0.	

Aircraft Propulsion Information Required When Using Turbo Fan/Jet Engines - Primary Engine

Cycle No.	0201	22.	Cruise engine selection
N_p	0204	4.	Number of cruise engines
h_{TO}	0207	0.	Takeoff pressure altitude for engine sizing
n	0208	1.04	Takeoff thrust/weight ratio 1.0 is required in this case but .04 has been added to allow for control and trim
ΔT_{INTO}	0209	27.	Takeoff ambient temperature = 86°F (27.° above standard)
N_{po}	0211	0.	Number of cruise engines inoperative in hover. In this case we know the lift engine out condition is critical.
N_{LO}	0212	0.7	Number of lift engines inoperative. Actually 1.0 in this case but reduced to .7 because of 1.1 emergency rating or equivalent of 3.3 engines operating
POWIND	0213	2.0	Engine sizing will be done at normal power

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
h_C	0214	30000.	Cruise engine sizing altitude, feet
V_C	0215	466.	Cruise engine sizing speed, knots TAS
Tin_C	0216	0	Zero indicates standard atmosphere nonstandard increment in temperature would be entered in °F.
Lift Engine Cycle No.	0218	55.	Lift fan and gas generator Selected
N_L	0220	4.	Number of lift fans
N_L	0221	2.	Number of lift fan clusters chosen to give zero lift nacelle wetted area (see explanation for location 0138)
η_L	0231	1.1	Lift engine hover efficiency normally used for turning nozzle or similar losses. Here it is used to account for the fact that one gas generator inoperative out of four does not depreciate thrust by .75 but B $(0.75^{2/3}$ $(0.75)^{2/3}/.75 = 1$ all four fans are operating due to cross ducting.
η_{P2}	0232	.96	Cruise engine hover efficiency. 4 percent loss assumed for turning nozzles
SHP_E/SHP^*	0260	1.0	Engine sized at 100% power
$V_{R/C}$	0261	0.0	Engine sized at 0 ft/min vertical rate of climb

Aircraft Aerodynamics Information Sheet

C_{DUTi}	0301	.005	Profile drag coefficient of vertical tail at $R_e = 10^7$
C_{DHTi}	0302	.005	Profile drag coefficient of horizontal tail at $R_e = 10^7$
C_{DNi}	0303	.0025	Profile drag coefficient of primary engine nacelle at $R_e = 10^7$

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
C_{DLNi}	0304	0.0	Profile drag coefficient lift engine nacelles at $R_e = 10^7$
ΔC_D	0305	.001	Profile drag increment
Δfe FT^2	0307	0.0	Increment in equivalent flat plat area parasite drag of fuselage (ft^2)
No. of Pairs in Table	0308	8.0	Number of C_L-C_{DWi} Pairs in locations 317-330 and 335-342
K_{LN}	0311	1.0	Lift nacelle multiplicative drag factor
K_W	0312	1.2	Wing multiplicative drag factor
K_N	0313	2.5	Primary nacelle multiplicative drag factor
K_F	0314	1.3	Fuselage multiplicative drag factor
K_{VT}	0315	1.5	Vertical tail multiplicative drag factor
K_{HT}	0316	1.5	Horizontal tail multiplicative drag factor
C_{L1}	0317	0.0	
C_{L2}	0318	0.2	
C_{L3}	0319	0.4	Table of lift coefficients used in the development of wing profile drag.
C_{L4}	0320	0.6	
C_{L5}	0321	0.8	
C_{L6}	0322	1.0	
C_{L7}	0323	1.2	
C_{L8}	0324	1.4	
$(R_e/l)_i$	0330	$2.0\text{x}10^6$	Mean Reynolds number per foot for mission
$C_{l\alpha}$ RAD^{-1}	0331	6.28	Two dimensional wing lift coefficient slope

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
α_{LO} DEG.	0332	-3.0	Angle of attack where the lift equals zero
$(X/_c)_{ps}$	0333	0.3	Position of peak suction location on wing
$(X/_c)_{max_{c/c}}$	0334	0.35	Position of maximum thickness on wing
$C_{DWi}(1)$	0335	.0066	
$C_{DWi}(2)$	0336	.0063	
$C_{DWi}(3)$	0337	.0065	
$C_{DWi}(4)$	0338	.0072	Table of wing induced drag coefficients.
$C_{DWi}(5)$	0339	.0088	
$C_{DWi}(6)$	0340	.010	
$C_{DWi}(7)$	0341	.0128	
$C_{DWi}(8)$	0342	.0156	
Aircraft Weight Information Sheet			
W_{FE}LBS	0401	11040.	Weight of fixed equipment, in LBS.
W_{FUL}LBS	0402	1450.	Weight of fixed useful load in LBS.
W_{PL}LBS	0403	13200.	Weight of payload in LBS.
K_{CC}	0404	26.0	Cockpit controls weight factor
K_{FW}	0405	.015	Fixed wing controls weight factor
K_H	0406	40.0	Constant for flight control hydraulics
K_{SAS}	0407	175.0	Stability augmentation system (SAS) weight factor, usually in range of 20-100 LBS
K_{TM}	0408	0.0	Tilt mechanism weight factor
K_{UC}	0409	0.0	Upper control weight factor

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
$\Delta W_{FC}LBS$	0417	500.0	Flight controls increment of 500 lb. for VTOL phasing and mixing
ΔW_P	0418	0.0	Incremental propulsion group weight
ΔW_{ST}	0419	0.0	Structures group incremental weight, in LBS
K_{LES}	0421	0.0	Lift engine section added to fuselage weight
K_{LG}	0422	.043	Landing gear weight factor, percentage of gross weight
K_{MG}	0423	.8	Main landing gear weight factor
K_{TL}	0424	1.0	Tail load factor
K_{WF}	0425	.314	Wing binding relief moment
K_{WW}	0426	291.0	Detailed wing weight factor, adjusts the constant 220 in $W_W = 220a\ (k)^{.582}$ depending on the complexity of the control surfaces
K_Y	0427	.190	Pitch radius of gyration, feet
K_Z	0428	.280	Yaw radius of gyration, feet
K_{PES}	0429	.342	Primary engine section factor
ΔP_{PSI}	0450	7.5	Cabin pressure differential limit (psi)
$W_c lbs$	0451	0.0	Weight of concentrated load
Y_c	0452	0 0	Position of concentrated load outboard from C_L in wing semispans
K_{FS}	0454	.07	Fuel system weights factor
K_{LEI}	0455	.250	Lift engine installation, used to account for reaction control system
K_{PEI}	0456	.400	Primary engine weight factor

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
Taxi Information Sheet			
ATMIN1	0501	0.0	Taxi out standard day
ATMIN2	0502	0.0	Taxi in standard day
t_T(HR) 1st	0511	.0333	Taxi out 2 minutes
t_T(HR) 2nd	0512	.0333	Taxi in 2 minutes
K_{FL}	0531	1.0	Taxi out lift system running
K_{FL}	0532	0.	Taxi in lift system inoperative
Takeoff, Hover and Landing Information Sheet			
TOLIND	0601 0602	2.0 2.0	Takeoff and land sharing equal fraction of thrust from primary and lift engines
ATMIND	0611	0.	Takeoff standard day
ATMIND	0612	0.	Landing standard day
n_T	0651	1.	Takeoff mean T/W = 1.
n_T	0651	1.	Landing T/W would normally be a mean value of .43. It has been increased to 1.0 to account for the go-around required in the reserves.
Δt_H	0661	.0167	Takeoff compute in 1 minute increments
Δt_H	0662	.0167	Landing compute in 1 minute increments
t_H	0681	.0167	Takeoff in 1 minute
t_H	0682	.0875	Landing in 5.25 minutes
$V_{R/C}$	2321 2322	0.0 0.0	No vertical rate of climb specified
Climb Information Sheet			
CLMIND	0691	1.0	Climb at speed for max. R/C
ATMIND	0711	0.0	Climb standard day
Δh	0721	1000.0	Compute in 1000. foot increments

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
$h_{MAX}FT$	0741	50000.	The airplane will climb to altitude for minimum fuel consumed during climb and cruise so long as the altitude is below 50,000 ft.
POWIND	0751	1.0	Climb at mil power
θ_{MAX}	0761	12.0	Maximum cabin angle, degrees
$\Delta C_{D_{CLIMB}}$	0781	0.0	No drag increment required
Δn_{CLIMB}	0791	0.0	Nominally zero

Cruise Information Sheet

CRSIND	0801	6.000	Cruise climb (constant W/δ at speed for 99% of best range)
HEADWIND	0811	0.0	Headwind for airplane is zero in this case, input is read as headwind when CRSIND is equal to 3 thru 6.
ATMIND	0821	0.0	Cruise @ standard day
ΔR	0831	25.0	Increment for calculations
R_{MAX}	0851	434.	Range at end of cruise calculations. Cruise is followed by a descent. The descent terminates at R = 434 n.m.
POWIND	0861	2.0	Cruise limited by normal power
$N_{PSD_{CR}}$	0871	0.0	No cruise engines inoperative during cruise
ΔC_{DCR}	0891	0.0	No drag increment (for shutdown engine)

Descent Information Sheet

DESIND	0901	3.0	Descent at idle power
ATMIND	0921	0.0	Descent standard day
τ_{MIN}	0931	-6.0	Cabin angle not to exceed six degree, nose down

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
Δh	0951	1000.	Compute in 1000. FT increments
R_{MAX}	0961	434.	Terminate descent at R = 434 nmi.
h_{MIN}	0971	0.0	Altitude at completion of descent
$\Delta C_{DDESC_{CR}}$	0991	0.0	No drag incrent used

Loiter Information Sheet

LTRIND	1001	2.0	Loiter indicator, fuel is for reserves and will not be printed out in the mission data
Δt_L	1011	0.10	Compute loiter in 6 MIN (.1HR) increments
ATMIND	1021	0.0	Loiter standard day
t_L	1031	.5	Loiter for 1/2 hour
$N_{PSD_{LOITER}}$	1051	0.0	Number of engines inoperative
$\Delta C_{D_{LOITER}}$	1071	0.0	No drag increment used (for shutdown engines)

Primary Engine Data

WDTIND	1201	1.0	Engine is flat rated by fuel flow restriction
$\dot{W}_{MAX}/\dot{W}$	1220	.8	Maximum fuel flow is 80% of fuel flow at maximum static thrust, sea level standard

Primary Engine Cycle Information Sheet Number 1

Cycle No.	1301	22.	Primary engine cycle number
K_3	1302	.122	Primary engine weights multiplicative factor
K_4	1303	95.	Primary engine weights additional factors
T_{GI}(°R)	1305	1417	Turbine inlet temperature, ground idle power setting

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
T_{FI}(°R)	1306	1776	Turbine inlet temperature, flight idle power setting
T_{NP}(°R)	1307	2340	Turbine inlet temperature. normal power setting. When this power setting is desired the input temperature is referred for the given altitude. The referred temperature, T/θ is used in the table lookup for referred fuel flow, Gas generator RPM limit, and power turbine limit.
T_{MIL}(°R)	1308	1444	Tubine inlet temperature, military power setting when this setting is desired the temperature is referred for the given altitude. The referred temperature, T/θ, is used in the beforementioned table look-ups.
T_{MAX}(°R)	1309	2600.00	Turbine inlet temperture, maximum power setting when this power setting when this power setting is specified the input temperature is referred for the given altitude. The referred temperature, T/θ, is used in the beforementioned table lookup.
No. of T/θ	1310	4.0	Number of referred temperatures in locations 1311-1318
Values of T/θ	1311	1339.0	Values of referred temperatures for the referred thrust or horsepower tables
	1312	2080.	
	1313	2600.	
	1314	3458	
No. of M.	1319	6.0	Number of mach numbers in locations 1320-1325
Values of M.	1320	0.0	Values of mach number for the referred thrust or horsepower tables
	1321	.2	
	1322	.4	
	1323	.6	
	1324	.8	
	1325	1.0	

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
Referred, Thrust or Horsepower	1326	0.0	Values of referred thrust or horsepower corresponding to T/θ location 1311 and mach number found in locations 1320 - 1325
	1327	-.04	
	1328	-.09	
	1329	-.185	
	1330	-.33	
	1331	-.49	
	1332	.55	Values of referred thrust or horsepower corresponding to T/θ location 1312 and mach number found in locations 1320 - 1325
	1333	.445	
	1334	.375	
	1335	.315	
	1336	.240	
	1337	.150	
	1338	.980	Values of referred thrust or horsepower corresponding to T/θ location 1313 and mach number found in locations 1320 - 1325
	1339	.860	
	1340	.750	
	1341	.700	
	1342	.650	
	1343	.595	
	1344	1.70	Values of referred thrust or horsepower corresponding to T/θ location 1314 and mach number found in locations 1320 - 1325
	1345	1.58	
	1346	1.46	
	1347	1.375	
	1348	1.265	
	1349	1.330	
No. of T/θ	1374	4.0	Number of referred temperatures in location 1375 - 1382
Values of T/θ	1375	1339.	Values of referred temperatures for the referred fuel flow table
	1376	2080.	
	1377	2600.	
	1378	3458.	
No. of M.	1383	6.	Number of mach numbers in locations 1384 - 1389
Values of M	1384	0.	Values of mach number for the referred fuel flow table
	1385	.2	
	1386	.4	
	1387	.6	
	1388	.8	
	1389	1.0	

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
	1390	.013	
	1391	.013	Values of referred fuel flow
	1392	-.017	correspond to the T/θ loca-
	1393	-.079	tion 1375 and mach numbers
	1394	-.205	in locations 1384 - 1389
	1395	-.390	
	1396	.26	
	1397	.265	Values of referred fuel flow
	1398	.210	correspond to the T/θ loca-
	1399	.270	tion 1376 and mach numbers
	1400	.222	in locations 1384 - 1389
	1401	.170	
	1402	.530	
	1403	.540	Values of referred fuel flow
	1404	.550	correspond to the T/θ loca-
	1405	.571	tion 1377 and mach numbers
	1406	.572	in locations 1384 - 1389
	1407	.589	
	1408	1.040	
	1409	1.072	Values of referred fuel flow
	1410	1.105	correspond to the T/θ loca-
	1411	1.170	tion 1378 and mach numbers
	1412	1.211	in locations 1384 - 1389
	1413	1.345	

Primary Engine Cycle Information Sheet Number 2

No. of T/θ	1438	8.0	
	1439	1300.	
	1440	1560.	
	1441	1820.	Values of referred temperatures
	1442	2080.	for the referred gas generator
	1443	2340.	RPM
	1444	2600.	
	1445	3120.	
	1446	3640.	
No. of M.	1447	6.0	Number of mach numbers in loca- tions 1448 - 1453
Value of M.	1448	0.0	
	1449	0.2	
	1450	0.4	Values of mach number for the
	1451	0.6	referred gas generator RPM
	1452	0.8	
	1453	1.0	

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
Referred Gas	1454	.679	
Generator	1455	.678	Values of referred gas generator
RPM	1456	.677	RPM limit corresponding to T/θ
	1457	.676	location 1439 and mach number
	1458	.675	locations 1448 - 1453
	1459	.673	
	1460	.740	
	1461	.7385	Values of referred gas generator
	1462	.737	RPM limit corresponding to T/θ
	1463	.735	location 1440 and mach number
	1464	.732	locations 1448 - 1453
	1465	.730	
	1466	.804	
	1467	.802	Values of referred gas generator
	1468	.799	RPM limit corresponding to T/θ
	1469	.797	location 1441 and mach number
	1470	.794	locations 1448 - 1453
	1471	.789	
	1472	.868	
	1473	.865	Values of referred gas generator
	1474	.8625	RPM limit corresponding to T/θ
	1475	.860	location 1442 and mach number
	1476	.855	locations 1448 - 1453
	1477	.849	
	1478	.934	
	1479	.931	Values of referred gas generator
	1480	.928	RPM limit corresponding to T/θ
	1481	.925	location 1443 and mach number
	1482	.918	locations 1448 - 1453
	1483	.910	
	1484	1.0	
	1485	.997	Values of referred gas generator
	1486	.9945	RPM limit corresponding to T/θ
	1487	.992	location 1444 and mach number
	1488	.983	locations 1448 - 1453
	1489	.974	
	1490	1.145	
	1491	1.140	Values of referred gas generator
	1492	1.136	RPM limit corresponding to T/θ
	1493	1.131	location 1445 and mach number
	1494	1.119	locations 1448 - 1453
	1495	1.107	

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
	1496	1.292	
	1497	1.286	Values of referred gas generator
	1498	1.281	RPM limit corresponding to T/θ
	1499	1.276	location 1445 and mach number
	1500	1.263	locations 1448 - 1453
	1501	1.250	
No. of T/θ	1502	8.0	Number of referred temperatures in locations 1503 - 1511
Values of T/θ	1503	1300.	
	1504	1560.	
	1505	1820.	Values of referred temperature
	1506	2080.	for the referred power turbine
	1507	2340.	speed limit ratio
	1508	2500.	
	1509	3120.	
	1510	3510.	
No. of M	1511	6.	Number of mach numbers in locations 1512 - 1517
Values of M	1512	0.0	
	1513	0.2	Values of mach number for the
	1514	0.4	referred power turbine speed
	1515	0.6	limit ratio
	1516	0.8	
	1517	1.0	
Referred Power	1518	.12	
Turbine Limit	1519	.17	Values of referred power turbine
Table	1520	.22	speed limit corresponding to T/θ
	1521	.272	location 1503 and mach number
	1522	.352	locations 1512 - 1517
	1523	.412	
	1524	.382	
	1525	.419	Values of referred power turbine
	1526	.455	speed limit corresponding to T/θ
	1527	.499	location 1504 and mach number
	1528	.549	locations 1512 - 1517
	1529	.599	
	1530	.601	
	1531	.626	Values of referred power turbine
	1532	.650	speed limit corresponding to T/θ
	1533	.680	location 1505 and mach number
	1534	.712	locations 1512 - 1517
	1535	.754	

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
	1536	.774	
	1537	.788	Values of referred power turbine
	1538	.801	speed limit corresponding to T/θ
	1539	.820	location 1506 and mach number
	1540	.847	locations 1512 - 1517
	1541	.880	
	1542	.900	
	1543	.912	Values of referred power turbine
	1544	.924	speed limit corresponding to T/θ
	1545	.940	location 1507 and mach number
	1546	.960	locations 1512 - 1517
	1547	.988	
	1548	1.00	
	1549	1.01	Values of referred power turbine
	1550	1.02	speed limit corresponding to T/θ
	1551	1.032	location 1508 and mach number
	1552	1.049	locations 1512 - 1517
	1553	1.073	
	1554	1.16	
	1555	1.166	Values of referred power turbine
	1556	1.172	speed limit corresponding to T/θ
	1557	1.180	location 1509 and mach number
	1558	1.190	locations 1512 - 1517
	1559	1.204	
	1560	1.261	
	1561	1.264	Values of referred power turbine
	1562	1.266	speed limit corresponding to T/θ
	1563	1.275	location 1510 and mach number
	1564	1.280	locations 1512 - 1517
	1565	1.284	
Lift Engine Cycle			
Cycle No.	1601	55.	Lift engine cycle number
K_1	1602	.157	Lift engine weights multiplicative factors
K_2	1603	-610.	Lift engine weights additional factors
ξ_1	1604	.0512	
ξ_2	1605	0.0	} Lift engine dimensional factors
ξ_3	1606	.0855	

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
T_{GI}	1607	1331.	Turbine inlet temperature at ground idle power setting, °R
T_{MAX}	1608	2600.	Turbine inlet temperature at max. power setting
Values of T/θ	1609	1300.	
	1610	1560.	
	1611	1820.	
	1612	2080.	Values of referred temperature for the referred thrust tables
	1613	2340.	
	1614	2600.	
	1615	3120.	
	1616	3458.	
Referred Thrust Table	1617	0.0	
	1618	.180	
	1619	.372	
	1620	.575	Values of referred thrust corresponding to T/θ locations 1609 - 1616
	1621	.782	
	1622	1.00	
	1623	1.433	
	1624	1.710	
Values of T/θ	1625	1300.	
	1626	1560.	
	1627	1820.	
	1628	2080.	Values of referred temperature for the referred fuel flow table
	1629	2340.	
	1630	2600.	
	1631	3120.	
	1632	3458.	
Table of Referred Fuel Flow	1633	.0379	
	1634	.0682	
	1635	.127	Values of referred fuel flow corresponding to T/θ locations 1625 - 1632
	1636	.199	
	1637	.235	
	1638	.379	
	1639	.5837	
	1640	.7201	
Values of T/θ	1641	1200.	
	1642	1440.	
	1643	1680.	Values of referred temperature for referred gas generator RPM table
	1644	1920.	
	1645	2160.	
	1646	2400.	
	1647	2880.	
	1648	3360.	

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
Referred Gas	1649	.679	
Generator	1650	.740	
RPM Table	1651	.804	Values of referred gas generator
	1652	.868	RPM corresponding to T/θ Loca-
	1653	.934	tions 1641 - 1649
	1654	1.000	
	1655	1.145	
	1656	1.292	
Values of T/θ	1657	1200.	
	1658	1440.	
	1659	1680.	Values of referred temperature
	1660	1920.	for referred power turbine speed
	1661	2160.	unit
	1662	2400.	
	1663	2880.	
	1664	3240.	
Referred Power	1665	.1200	
Turbine Limit	1666	.382	
Table	1667	.001	Values of referred power turbine
	1668	.774	limit corresponding to T/θ loca-
	1669	.90	tions 1657 - 1664
	1670	1.0	
	1671	1.16	
	1672	1.261	
Run 2			
KPRINT	0002	0.0	Standard printout
Run 3			
OPTIND	0001	0.0	Weights data only
End of Data			

V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

THE FOLLOWING IS A CARD BY CARD REPRODUCTION OF THE INPUT DECK FOR THIS CASE

LOC. CORRESPONDS TO LOCATION NUMBER GIVEN ON INPUT SHEET
NUM STANDS FOR THE NUMBER OF SEQUENTIAL INPUT VALUES STARTING WITH LOC. (MAX. =5)
VAL EQUALS VALUE FOR VARIABLE CORRESPONDING TO LOC.
VAL1 VALUE CORRESPONDING TO LOC.+0001
VAL2 VALUE CORRESPONDING TO LOC.+0002
ETC.

LOC.	NUM	VAL	VAL1	VAL2	VAL3	VAL4
1301	3	22.000	.12200	95.000		
1305	5	1417.0	1776.0	2340.0	2444.0	2600.0
1310	5	4.0000	1339.0	2080.0	2600.0	3458.0
1319	5	6.0000	.0	.20000	.40000	.60000
1324	5	.80000	1.0000	.0	-.40000E-01	-.90000E-01
1329	5	-.18500	-.33000	-.49000	.55000	.44500
1334	5	.37500	.31500	.24000	.15000	.98000
1339	5	.86000	.76000	.70000	.65000	.59500
1344	5	1.7000	1.5800	1.4600	1.3750	1.2650
1349	1	1.3300				
1374	5	4.0000	1339.0	2080.0	2600.0	3458.0
1383	5	6.0000	.0	.20000	.40000	.60000
1388	5	.80000	1.0000	.13000E-01	.13000E-01	-.17000E-01
1393	5	-.79000E-01	-.20500	-.39000	.26000	.26500
1398	5	.27000	.27000	.22200	.17000	.53000
1403	5	.54000	.55000	.57100	.57200	.58900
1408	5	1.0400	1.0720	1.1050	1.1700	1.2110
1413	1	1.3450				
1438	5	8.0000	1300.0	1560.0	1820.0	2080.0
1443	5	2340.0	2600.0	3120.0	3640.0	6.0000
1448	5	.0	.20000	.40000	.60000	.80000
1453	5	1.0000	.67900	.67800	.67700	.67600
1458	5	.67500	.67300	.74000	.73850	.73700
1463	5	.73500	.73200	.73000	.80400	.80200
1468	5	.79900	.79700	.79400	.78900	.86800
1473	5	.86500	.86250	.86000	.85500	.84900
1478	5	.93400	.93100	.92800	.92500	.91800
1483	5	.91000	1.0000	.99700	.99450	.99200
1488	5	.98300	.97400	1.1450	1.1400	1.1360
1493	5	1.1310	1.1190	1.1070	1.2920	1.2860
1498	4	1.2810	1.2760	1.2630	1.2500	
1502	5	8.0000	1300.0	1560.0	1820.0	2080.0
1507	5	2340.0	2600.0	3120.0	3510.0	6.0000
1512	5	.0	.20000	.40000	.60000	.80000
1517	5	1.0000	.12000	.17000	.22000	.27200
1522	5	.35200	.41200	.38200	.41900	.45500
1527	5	.49900	.54900	.59900	.60100	.62600
1532	5	.65000	.68000	.71200	.75400	.77400
1537	5	.78800	.80[illegible]00	.82000	.84700	.88000
1542	5	.90000	.91200	.92400	.94000	.96000
1547	5	.98800	1.0000	1.0100	1.0200	1.0320
1552	5	1.0490	1.0730	1.1600	1.1660	1.1720

1557	5	1.1800	1.1900	1.2040	1.2610	1.2640
1562	4	1.2660	1.2750	1.2800	1.2840	
1601	5	55.000	.15700	-610.00	.51200E-01	.0
1606	5	.85500E-02	1331.0	2600.0	1300.0	1560.0
1611	5	1820.0	2080.0	2340.0	2600.0	3120.0
1616	5	3458.0	.0	.18000	.37200	.57500
1621	5	.78200	1.0000	1.4330	1.7100	1300.0
1626	5	1560.0	1820.0	2080.0	2340.0	2600.0
1631	5	3120.0	3458.0	.37900E-01	.68200E-01	.12700
1636	5	.19900	.28500	.37900	.58370	.72010
1641	5	1200.0	1440.0	1680.0	1920.0	2160.0
1646	5	2400.0	2330.0	3360.0	.67900	.74000
1651	5	.80400	.86800	.93400	1.0000	1.1450
1656	5	1.2920	1200.0	1440.0	1680.0	1920.0
1661	5	2160.0	2400.0	2880.0	3240.0	.12000
1666	5	.38200	.60100	.77400	.90000	1.0000
1671	2	1.1600	1.2610			
1	4	1.0000	1.0000	.0	1.0000	
6	5	2.0000	.0	1.0000	1.0000	1.0000
11	1	1.0000				
13	1	1.0000				
14	4	70000.	.0	.0	.0	
18	2	1.0000	1.0000			
20	3	.83000	400.00	450.00		
23	1	2.5000				
24	3	1.0000	.0	1.0000		
27	5	1.0000	2.0000	3.0000	4.0000	5.0000
32	4	6.0000	2.0000	1.0000	100.00	
101	1	3.2000				
103	5	2.0000	.14500	.10000	75.000	35.000
108	1	.23000				
109	5	3.3000	.0	36.000	.10000	.60000
114	1	.45000				
120	1	.0				
123	2	1.8500	2.5000			
126	1	.0				
129	5	1.5000	32.500	.10000	.10000	.45000
135	1	.0				
136	1	.48000				
137	2	.0	-2.0000			
139	3	.33400E-01	.0	.11050		
151	1	.0				
153	5	60.000	5.0000	1.0000	22.000	36.000
158	1	18.000				
159	1	.0				
161	5	.0	.0	.0	.0	.0
166	1	.0				
201	1	22.000				
204	1	4.0000				
207	3	.0	1.0400	27.000		
211	2	.0	.70000			
213	4	2.0000	30000.	466.00	.0	
218	1	55.000				
220	2	4.0000	2.0000			
231	2	1.1000	.96000			
301	5	.50000E-02	.50000E-02	.25000E-02	.0	.10000E-02
307	2	.0	8.0000			
311	5	1.0000	1.2000	2.5000	1.3000	1.5000
316	5	1.5000	.0	.20000	.40000	.60000
321	4	.80000	1.0000	1.2000	1.4000	

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 330    1    .20000E+07
 331    2    6.2800       -3.0000
 333    2    .30000        .35000
 335    5    .66000E-02    .63000E-02    .65000E-02    .72000E-02    .88000E-02
 340    3    .10000E-01    .12900E-01    .15600E-01
 401    3    11040.        1450.0        13200.
 404    5    25.000        .15000E-01    40.000        175.00        .0
 409    1    .0
 417    3    500.00        .0            .0
 420    5    125.00        .0            .43000E-01    .80000        1.0000
 425    5    .31400        291.00        .19000        .28000        .34200
 450    3    7.5000        .0            .0
 454    3    .70000E-01    .25000        .40000
 501    2    .0            .0
 511    2    .33300E-01    .33300E-01
 531    2    1.0000        .0
 601    2    2.0000        2.0000
 611    2    .0            .0
 651    2    1.0000        1.0000
 661    2    .16700E-01    .15700E-01
 681    2    .16700E-01    .87500E-01
 691    1    1.0000
 711    1    .0
 721    1    1000.0
 741    1    50000.
 751    1    1.0000
 761    1    12.000
 781    1    .0
 791    1    .0
 801    1    6.0000
 811    1    .0
 821    1    .0
 831    1    25.000
 851    1    434.00
 861    1    2.0000
 871    1    .0
 891    1    .0
 901    1    3.0000
 921    1    .0
 931    1   -6.0000
 951    1    1000.0
 961    1    434.00
 971    1    .0
 991    1    .0
1001    1    2.0000
1011    1    .10000
1021    1    .0
1031    1    .50000
1051    1    .0
1071    1    .0
1201    1    1.0000
1220    1    .80000
 260    2    1.0000        .0
2321    2    .0            .0
WG = 0.700000E+05  WFA = 0.0          WFR = 0.0
WG = 0.700000E+05  WFA = 0.682529E+04  WFR = 0.106524E+05
WG = 0.754672E+05  WFA = 0.962225E+04  WFR = 0.113911E+05
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V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

S I Z E D A T A THIS RUN CONVERGED IN 3 ITERATIONS

GROSS WEIGHT = 80166. LB

FUSELAGE			
LF	LENGTH	83.2	FT
WF	WIDTH	11.4	FT
SF	WETTED AREA	2496.	SQFT
WING			
AR	ASPECT RATIO	3.20	
SW	AREA	1068.9	SQFT
B	SPAN	58.5	FT
CBARW	GEOM. MEAN CHORD	18.3	FT
LAMBDA C/4	QUARTER CHORD SWEEP	35.0	DEG
LAMBDA	TAPER RATIO	0.230	
(T/C)R	ROOT THICKNESS	0.145	
(T/C)T	TIP THICKNESS	0.100	
WG/SW	WING LOADING	75.0	LB/SQFT
HOR. TAIL			
ARHT	ASPECT RATIO	3.30	
SHT	AREA	325.6	SQFT
BHT	SPAN	32.8	FT
CBARHT	MEAN CHORD	9.9	FT
(T/C)HT	THICKNESS / CHORD	0.100	
LTH	MOMENT ARM	36.0	FT
VERT. TAIL			
ARVT	ASPECT RATIO	1.50	
SVT	AREA	192.3	SQFT
BVT	SPAN	17.0	FT
CBARVT	MEAN CHORD	11.3	FT
(T/C)VT	THICKNESS / CHORD	0.100	
LTV	MOMENT ARM	32.5	FT
PRIMARY ENG. NACELLE			
LN	LENGTH	9.4	FT
DBARN	MEAN DIAMETER	2.8	FT
SN	WETTED AREA	337.2	SQRT
LIFT ENG. NACELLE			
LNG	LENGTH	0.0	FT
LLN	DEPTH	1.2	FT
DBARLN	MEAN DIAMETER	7.	FT
SLN	WETTED AREA	0.	SQFT
PROPELLER			

NO PROPELLER ON THIS AIRCRAFT

V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM   B-93

P A S S E N G E R   S I Z I N G   D A T A

	TOURIST	FIRST CLASS
NO. OF PASS.	0.	60.
NO. ABREAST	0.	5.
NO.OF AISLES	0.	1.
UNIT SEAT WIDTH	0. IN.	22. IN.
SEAT PITCH	0. IN.	36. IN.
AISLE WIDTH	0. IN.	18. IN.

NUMBER OF LAVATORIES	2.00	
GALLEY AREA	39.0 SQ. FT.	
CLOSET AREA	6.3 SQ. FT.	
CABIN DIAMETER	129.1 IN.	*** FIRST CLASS CRITICAL
BODY DIAMETER	137.4 IN.	*** FIRST CLASS CRITICAL

NOSE SECTION LENGTH	21.2 FT.
TAIL SECTION LENGTH	28.6 FT.
CONST. DIA. LENGTH	33.4 FT.
TOTAL FUSELAGE LENGTH	83.2 FT.

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                                   V A S C O M P  II
          V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93

   P R O P U L S I O N   D A T A
         PRIMARY PROPULSION CYCLE NO.   22.000
                  TURBOFAN   ENGINE

                   4.  ENGINES

            T*P            MAX. STANDARD S.L. STATIC THRUST       29160.     LB

            ENGINE SIZED FOR CRUISE AT VC = 466. KNOTS,
            HC = 30000. FT, TEMPERATURE = -47.98 DEG F.

         LIFT ENGINE CYCLE NO.   55.000
                  LIFT FAN      ENGINE
          4.  ENGINES IN  2. CLUSTERS
            T*L            MAX. STANDARD S.L. STATIC THRUST       75327.     LB

         ENGINE SIZED FOR TAKEOFF WITH T/W = 1.04.,
         100.0 PERCENT POWER,
         AUGMENTED BY PRIMARY PROPULSION OF  80.PER CENT

                 CRITICAL SIZING CONDITION IS  0.700 LIFT ENGINES INOPERATIVE
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V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

W E I G H T S D A T A IN LBS

GLF	GUST LOAD FACTOR	2.654		
STRUCTURES GROUP				
K8 WW	WING	5948.		
K9 WHT	HOR. TAIL	1183.		
K10 WVT	VERT. TAIL	715.		
K11 WB	FUSELAGE	9832.		
K12 WLG	LANDING GEAR	3447.		
K13 WLES	LIFT ENGINE SECTION	0.		
K14 WPES	PRIMARY ENGINE SECTION	1347.		
DELTA WST	STRUCTURE WEIGHT INCREMENT	0.		
WST	TOTAL STRUCTURE WEIGHT	22471.		
PROPULSION GROUP				
K2 WR/P	ROTOR OR PROP	0.		
K3 WDS	DRIVE SYSTEM	0.		
K4 WEL	LIFT ENGINES	9386.		
K5 WEP	PRIMARY ENGINES	3937.		
K6 WLEI	LIFT ENGINE INSTALLATION	2347.		
K7 WPEI	PRIMARY ENGINE INSTALLATION	1575.		
K21 WFS	FUEL SYSTEM	832.		
DELTA WP	PROPULSION GROUP WEIGHT INCREMENT	0.		
WP	TOTAL PROPULSION GROUP WEIGHT	18078.		
FLIGHT CONTROLS GROUP				
K15 WCC	COCKPIT CONTROLS	157.		
K16 WUC	UPPER CONTROLS	0.		
K17 WH	HYDRAULICS	0.		
K18 WFW	FIXED WING CONTROLS	1202.		
K19 WSAS	SAS	175.		
K20 WTM	TILT MECHANISM	0.		
DELTA WFC	CONTROL WEIGHT INCREMENT	500.		
WFC	TOTAL CONTROL WEIGHT	2034.		
WFE	WEIGHT OF FIXED EQUIPMENT	11040.		
WE	WEIGHT EMPTY	53623.		
WFUL	FIXED USEFUL LOAD	1450.		
OWE	OPERATING WEIGHT EMPTY	55073.		
WPL	PAYLOAD	13200.		
(WF)A	FUEL	11893.	(WF)W	10973.
WG	GROSS WEIGHT	80166.		

VASCOMP II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

AERODYNAMICS DATA

FE	TOTAL EFFECTIVE FLATPLATE AREA	19.489	SQFT
SWET	TOTAL WETTED AREA	5693.	SQFT
CBARF	MEAN SKIN FRICTION COEFF.	0.003424	

DRAG BREAKDOWN IN SQFT

FEW	WING FE	6.923
FEF	FUSELAGE FE	6.131
FEVT	VERT. TAIL FE	1.268
FEHT	HOR. TAIL FE	2.191
FEN	PRIMARY ENG. NACELLE FE	1.906
FELN	LIFT ENG. NACELLE FE	0.0
DELTA FE	INCREMENTAL FE	1.069

AERODYNAMIC COEFF.

A1		0.83950	
A2		-0.13007	
A3		0.02221	
A4		0.09636	
A5		0.01176	
A6		0.98140	
A7		0.11831	
CL ALPHA	3-D LIFT SLOPE	3.72296	PER RADIAN
E	OSWALD FACTOR	0.84075	

V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

MISSION PERFORMANCE DATA

TAXI FOR 0.033 HRS. AT GROUND IDLE ENGINE RATING TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	LETF
0.0	0.0	0.0	80166.	0.	0.0	1417.0	T	0.067	0.021
0.033	0.0	130.8	80035.	0.	0.0	1417.0	T	0.067	0.021

TAKEOFF, HOVER, OR LAND AT T/W = 1.000 FOR 0.017.HRS.
VERTICAL RATE OF CLIMB = 0.0 FT/MIN TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	LETF	THRUST TO WEIGHT	FM	BHP	CT	VTIP (FPS)
0.033	0.0	130.8	80035.	0.	0.0	2165.2	P	0.757	0.757	1.000	0.960			
0.050	0.0	623.3	79543.	0.	0.0	2160.5	P	0.752	0.752	1.000	0.960			

CLIMB TO OPT. ALT. FOR NEXT CRUISE WITH MAXIMUM R/C AT MILITARY. ENGINE RATING, MAXIMUM ALT. 50000. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	GAMMA (DEG)	THETA -F (DEG)	R/C (FPM)
CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW (LBS/HR)	BHP		THRUST (LBS)	CP	CT	J	VTIP (FPS)	ETAP	
0.050	0.0	623.3	79543.	0.	250.0	2377.5	W	1.000	250.0	0.378	0.794	7.3	7.7	3232.
0.348	0.0324	10.737	78892.	7348.	12364.	0.		17496.	******	******	******	0.0	1.000	
0.055	1.28	687.0	79479.	1000.	253.7	2391.9	W	1.000	250.0	0.385	0.794	6.7	7.1	3019.
0.348	0.0324	10.749	78929.	7343.	12364.	0.		17451.	******	******	******	0.0	1.000	
0.061	2.67	755.3	79411.	2000.	257.5	2407.0	W	1.000	250.0	0.392	0.794	6.7	7.1	3045.
0.348	0.0324	10.749	78868.	7338.	12364.	0.		17404.	******	******	******	0.0	1.000	
0.066	4.07	823.0	79343.	3000.	261.3	2422.7	W	1.000	250.0	0.399	0.794	6.7	7.0	3071.
0.348	0.0324	10.748	78807.	7332.	12364.	0.		17357.	******	******	******	0.0	1.000	
0.072	5.48	890.1	79276.	4000.	265.3	2438.2	W	1.000	250.0	0.407	0.794	6.6	7.0	3096.
0.348	0.0324	10.747	78748.	7327.	12364.	0.		17303.	******	******	******	0.0	1.000	
0.077	6.90	956.6	79209.	5000.	269.3	2444.0	T	0.988	250.0	0.414	0.794	6.4	6.8	3057.
0.348	0.0323	10.747	78711.	7324.	12217.	0.		17050.	******	******	******	0.0	1.000	
0.082	8.36	1023.3	79142.	6000.	273.4	2444.0	T	0.970	250.0	0.422	0.794	6.2	6.5	2980.
0.347	0.0323	10.746	78683.	7322.	11987.	0.		16686.	******	******	******	0.0	1.000	
0.088	9.88	1090.3	79075.	7000.	277.7	2444.0	T	0.952	250.0	0.430	0.794	5.9	6.3	2903.
0.347	0.0323	10.745	78653.	7320.	11757.	0.		16325.	******	******	******	0.0	1.000	
0.094	11.47	1157.8	79008.	8000.	282.0	2444.0	T	0.934	250.0	0.438	0.794	5.7	6.0	2824.

0.347	0.0323	10.744	78621.	7318.	11529.	0.		15967.	******	******	******	0.0	1.000	
0.100	13.13	1225.8	78940.	9000.	286.4	2444.0	T	0.917	250.0	0.447	0.794	5.4	5.8	2743.
0.347	0.0323	10.743	78586.	7315.	11301.	0.		15613.	******	******	******	0.0	1.000	
0.106	14.86	1294.5	78871.	10000.	290.9	2444.0	T	0.899	250.0	0.456	0.794	5.2	5.5	2661.
0.347	0.0323	10.742	78549.	7312.	11075.	0.		15261.	******	******	******	0.0	1.000	
0.112	16.68	1363.9	78802.	11000.	322.1	2444.0	T	0.888	272.4	0.506	0.802	5.2	4.7	2944.
0.292	0.0281	10.383	78480.	7559.	10944.	0.		14667.	******	******	******	0.0	1.000	
0.118	18.49	1425.8	78740.	12000.	324.9	2444.0	T	0.870	270.5	0.513	0.801	4.6	4.1	2634.
0.296	0.0284	10.426	78487.	7528.	10711.	0.		14348.	******	******	******	0.0	1.000	
0.124	20.54	1493.6	78672.	13000.	327.9	2444.0	T	0.855	268.6	0.519	0.801	4.4	4.0	2544.
0.300	0.0287	10.462	78441.	7498.	10480.	0.		14033.	******	******	******	0.0	1.000	
0.131	22.69	1562.2	78603.	14000.	330.8	2444.0	T	0.856	266.7	0.526	0.800	4.2	3.9	2452.
0.304	0.0290	10.496	78393.	7469.	10251.	0.		13719.	******	******	******	0.0	1.000	
0.137	24.93	1631.9	78534.	15000.	333.8	2444.0	T	0.857	264.8	0.533	0.799	4.0	3.7	2361.
0.308	0.0293	10.529	78342.	7441.	10025.	0.		13409.	******	******	******	0.0	1.000	
0.144	27.28	1702.7	78463.	16000.	336.9	2444.0	T	0.858	262.9	0.540	0.799	3.8	3.6	2267.
0.313	0.0296	10.560	78289.	7414.	9801.	0.		13102.	******	******	******	0.0	1.000	
0.152	29.76	1774.7	78391.	17000.	340.0	2444.0	T	0.859	261.0	0.547	0.798	3.6	3.5	2175.
0.317	0.0299	10.590	78234.	7388.	9579.	0.		12797.	******	******	******	0.0	1.000	
0.159	32.36	1848.1	78317.	18000.	343.1	2444.0	T	0.860	259.0	0.554	0.798	3.4	3.4	2080.
0.321	0.0303	10.618	78177.	7363.	9360.	0.		12496.	******	******	******	0.0	1.000	
0.167	35.11	1923.1	78242.	19000.	346.3	2444.0	T	0.861	257.1	0.561	0.797	3.2	3.3	1985.
0.326	0.0306	10.644	78117.	7339.	9143.	0.		12197.	******	******	******	0.0	1.000	
0.176	38.01	1999.9	78165.	20000.	349.6	2444.0	T	0.862	255.2	0.569	0.796	3.1	3.1	1889.
0.331	0.0310	10.669	78054.	7316.	8929.	0.		11902.	******	******	******	0.0	1.000	
0.185	41.09	2078.7	78087.	21000.	352.8	2444.0	T	0.863	253.2	0.576	0.796	2.9	3.0	1793.
0.336	0.0314	10.692	77988.	7294.	8718.	0.		11610.	******	******	******	0.0	1.000	
0.194	44.37	2159.7	78006.	22000.	356.2	2444.0	T	0.864	251.2	0.584	0.795	2.7	2.9	1695.
0.341	0.0318	10.712	77919.	7274.	8509.	0.		11321.	******	******	******	0.0	1.000	
0.204	47.87	2243.4	77922.	23000.	359.3	2444.0	T	0.865	249.1	0.592	0.794	2.5	2.9	1609.
0.346	0.0323	10.733	77846.	7253.	8302.	0.		11036.	******	******	******	0.0	1.000	
0.214	51.59	2329.4	77836.	24000.	361.1	2444.0	T	0.866	246.0	0.597	0.793	2.5	2.9	1570.
0.355	0.0330	10.757	77764.	7229.	8095.	0.		10762.	******	******	******	0.0	1.000	
0.225	55.43	2415.4	77750.	25000.	362.0	2444.0	T	0.867	242.3	0.601	0.792	2.4	3.0	1507.
0.365	0.0339	10.779	77684.	7207.	7886.	0.		10495.	******	******	******	0.0	1.000	
0.236	59.43	2502.6	77663.	26000.	362.6	2444.0	T	0.869	238.5	0.605	0.791	2.2	3.0	1411.
0.377	0.0349	10.794	77605.	7190.	7677.	0.		10230.	******	******	******	0.0	1.000	
0.248	63.71	2593.3	77572.	27000.	365.8	2444.0	T	0.871	236.3	0.613	0.790	1.9	2.7	1198.
0.383	0.0355	10.798	77531.	7180.	7471.	0.		9948.	******	******	******	0.0	1.000	
0.262	68.80	2697.2	77468.	28000.	369.1	2444.0	T	0.872	234.2	0.621	0.789	1.7	2.7	1088.

0.390	0.0361	10.798	77435.	7171.	7270.	0.		9668.	******	******	******	0.0	1.000	
0.277	74.46	2808.6	77356.	29000.	373.3	2444.0	T	0.874	232.6	0.631	0.788	1.4	2.5	954.
0.395	0.0365	10.797	77332.	7163.	7072.	0.		9385.	******	******	******	0.0	1.000	
0.294	80.98	2932.1	77233.	30000.	378.5	2444.0	T	0.876	231.5	0.642	0.788	1.2	2.4	824.
0.398	0.0368	10.795	77215.	7153.	6879.	0.		9099.	******	******	******	0.0	1.000	
0.315	88.64	3071.2	77094.	31000.	383.7	2444.0	T	0.878	230.4	0.654	0.787	1.1	2.2	716.
0.401	0.0371	10.792	77081.	7143.	6690.	0.		8816.	******	******	******	0.0	1.000	
0.338	97.58	3227.1	76938.	32000.	388.9	2444.0	T	0.880	229.2	0.666	0.787	0.9	2.1	611.
0.404	0.0375	10.786	76929.	7133.	6506.	0.		8539.	******	******	******	0.0	1.000	

CRUISE AT SPEED FOR 99 PER CENT BEST RANGE WITH HEADWIND OF 0.0 KNOTS TEMPERATURE = -55.1 DEG.F
CRUISE-CLIMB AT CONSTANT W/DELTA = 283989.

TIME (HRS) / CL	RANGE (N.M.) / CD	FUEL USED (LBS) / L/D	WEIGHT (LBS.) / LIFT (LBS)	PRES. ALT. (FT) / DRAG (LBS)	TAS (KTS) / FUEL FLOW (LBS/HR)	TURB. TEMP. (R) / BHP	ENG. CODE	PETF OR PEHF / THRUST (LBS)	EAS / CP	MACH / CT	MACH DIV / J	SPEC. RANGE (NMPP) / VTIP (FPS)	ETAP PROP
*** CAUTION - SPEED LIMITED BY THRUST AVAILABLE AT SPECIFIED POWER SETTING													
0.338	97.58	3227.1	76938.	32000.	465.5	2340.0	T	0.802	274.4	0.797	0.803	.07760	1.000
0.282	0.0274	10.282	76938.	7483.	5997	0.		7480.	******	******	******	0.0	
0.343	100.00	3258.2	76907.	32009.	465.5	2340.0	T	0.802	274.3	0.797	0.803	.07763	1.000
0.282	0.0274	10.282	76907.	7480.	5996.	0.		7478.	******	******	******	0.0	
0.397	125.00	3580.3	76585.	32099.	466.5	2340.0	T	0.802	274.4	0.799	0.803	.07794	1.000
0.281	0.0273	10.266	76585.	7460.	5984.	0.		7458.	******	******	******	0.0	
0.450	150.00	3901.0	76264.	32190.	467.5	2340.0	T	0.802	274.6	0.801	0.803	.07825	1.000
0.279	0.0272	10.249	76264.	7441.	5972.	0.		7437.	******	******	******	0.0	
0.504	175.00	4220.5	75944.	32280.	468.5	2340.0	T	0.802	274.7	0.803	0.803	.07856	1.000
0.278	0.0271	10.233	75944.	7422.	5961.	0.		7417.	******	******	******	0.0	
0.557	200.00	4538.7	75626.	32371.	469.5	2340.0	T	0.802	274.8	0.805	0.804	.07887	1.000
0.276	0.0270	10.216	75626.	7402.	5949.	0.		7396.	******	******	******	0.0	
0.610	225.00	4855.7	75309.	32461.	470.0	2340.0	T	0.802	274.6	0.806	0.804	.07918	1.000
0.276	0.0270	10.207	75309.	7378.	5936.	0.		7377.	******	******	******	0.0	
0.664	250.00	5171.5	74993.	32551.	471.0	2340.0	T	0.802	274.7	0.808	0.804	.07949	1.000
0.274	0.0269	10.190	74993.	7360.	5924.	0.		7357.	******	******	******	0.0	
0.717	275.00	5486.0	74679.	32641.	472.0	2340.0	T	0.803	274.9	0.810	0.804	.07979	1.000
0.273	0.0268	10.172	74679.	7342.	5913.	0.		7337.	******	******	******	0.0	
0.770	300.00	5799.3	74365.	32732.	472.5	2340.0	T	0.803	274.7	0.811	0.804	.08010	1.000
0.272	0.0268	10.161	74365.	7318.	5900.	0.		7318.	******	******	******	0.0	
0.775	302.45	5829.8	74335.	32741.	472.6	2340.0	T	0.803	274.7	0.811	0.804	.08013	1.000
0.272	0.0268	10.160	74335.	7317.	5899.	0.		7316.	******	******	******	0.0	

DESCEND T[illegible] = 0. FT. ,R = 434.00 N.MI. AT FLIGHT IDLE

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	GAMMA (DEG)	THETA -F (DEG)	R/S (FPM)
CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW (LBS/HR)	BHP		THRUST (LBS)	CP	CT	J	VTIP (FPS)	ETAP	
0.775	302.45	5829.7	74335.	32741.	275.5	1776.0	T	0.377	160.1	0.473	0.738	-13.8	-6.9	6666.
0.777	0.0917	8.477	72193.	8516.	2592.	0.		3870.	******	******	******	0.0	0.0	
0.777	303.12	5836.2	74328.	31741.	302.6	1776.0	T	0.368	179.2	0.517	0.758	-10.8	-6.2	5768.
0.627	0.0656	9.564	72998.	7633.	2664.	0.		3832.	******	******	******	0.0	0.0	
0.780	303.98	5843.9	74321.	30741.	327.7	1776.0	T	0.359	197.7	0.558	0.772	-9.5	-6.6	5499.
0.517	0.0502	10.306	73285.	7111.	2721.	0.		3792.	******	******	******	0.0	0.0	
0.783	304.96	5852.1	74312.	29741.	350.9	1776.0	T	0.349	215.6	0.594	0.783	-8.6	-6.9	5316.
0.436	0.0407	10.700	73468.	6866.	2765.	0.		3748.	******	******	******	0.0	0.0	
0.786	306.04	5860.8	74304.	28741.	371.0	1776.0	T	0.342	232.2	0.626	0.790	-7.1	-6.3	4663.
0.377	0.0350	10.794	73728.	6831.	2779.	0.		3711.	******	******	******	0.0	0.0	
0.790	307.36	5870.7	74294.	27741.	389.1	1776.0	T	0.334	248.0	0.654	0.796	-6.7	-6.6	4592.
0.331	0.0310	10.667	73786.	6917.	2785.	0.		3668.	******	******	******	0.0	0.0	
0.794	308.76	5880.8	74284.	26741.	404.2	1776.0	T	0.324	262.3	0.676	0.801	-5.8	-6.3	4160.
0.296	0.0284	10.426	73899.	7088.	2789.	0.		3624.	******	******	******	0.0	0.0	
0.798	310.38	5892.0	74272.	25741.	416.3	1776.0	T	0.314	275.0	0.693	0.804	-5.2	-6.0	3810.
0.270	0.0266	10.136	73965.	7297.	2794.	0.		3582.	******	******	******	0.0	0.0	
0.802	312.19	5904.2	74260.	24741.	426.3	1776.0	T	0.304	286.7	0.707	0.807	-5.0	-6.2	3753.
0.248	0.0253	9.823	73979.	7532.	2797.	0.		3538.	******	******	******	0.0	0.0	
0.806	314.08	5916.6	74248.	23741.	434.4	1776.0	T	0.293	297.3	0.718	0.809	-4.8	-6.2	3683.
0.231	0.0243	9.513	73987.	7778.	2799.	0.		3496.	******	******	******	0.0	0.0	
0.811	316.04	5929.3	74235.	22741.	439.5	1776.0	T	0.284	306.1	0.723	0.811	-4.4	-6.0	3392.
0.218	0.0236	9.246	74013.	8004.	2806.	0.		3464.	******	******	******	0.0	0.0	
0.816	318.19	5943.1	74221.	21741.	443.5	1776.0	T	0.275	314.3	0.727	0.813	-4.4	-6.2	3458.
0.207	0.0230	8.989	74001.	8233.	2813.	0.		3432.	******	******	******	0.0	0.0	
0.821	320.33	5956.6	74208.	20741.	445.5	1776.0	T	0.266	321.2	0.727	0.814	-4.2	-6.2	3329.
0.198	0.0226	8.769	74013.	8440.	2825.	0.		3410.	******	******	******	0.0	0.0	
0.826	322.55	5970.8	74193.	19741.	445.6	1776.0	T	0.259	326.7	0.724	0.815	-4.0	-6.1	3178.
0.191	0.0223	8.588	74011.	8619.	2845.	0.		3403.	******	******	******	0.0	0.0	
0.831	324.88	5985.7	74179.	18741.	444.6	1776.0	T	0.253	331.5	0.720	0.815	-4.0	-6.1	3146.
0.186	0.0220	8.428	73997.	8779.	2868.	0.		3401.	******	******	******	0.0	0.0	
0.836	327.23	6000.9	74163.	17741.	442.6	1776.0	T	0.246	335.6	0.714	0.816	-4.0	-6.2	3096.
0.181	0.0219	8.295	73986.	8920.	2896.	0.		3404.	******	******	******	0.0	0.0	
0.842	329.61	6016.5	74148.	16741.	439.6	1776.0	T	0.241	338.9	0.706	0.816	-3.9	-6.2	3026.
0.178	0.0217	8.187	73976.	9036.	2929.	0.		3413.	******	******	******	0.0	0.0	
0.847	332.03	6032.6	74131.	15741.	435.4	1776.0	T	0.236	341.2	0.697	0.817	-3.8	-6.1	2908.
0.175	0.0216	8.112	73972.	9119.	2971.	0.		3433.	******	******	******	0.0	0.0	

0.853	334.52	6049.6	74114.	14741.	430.1	1776.0	T	0.232	342.6	0.686	0.817	-3.7	-6.0	2794.
0.174	0.0216	8.066	73962.	9170.	3022.	0.		3463.	******	******	******	0.0	0.0	
0.859	337.08	6067.6	74096.	13741.	425.0	1776.0	T	0.228	344.1	0.675	0.817	-3.7	-6.1	2798.
0.172	0.0215	8.017	73945.	9224.	3073.	0.		3490.	******	******	******	0.0	0.0	
0.865	339.61	6085.9	74078.	12741.	420.2	1776.0	T	0.229	345.7	0.665	0.817	-3.8	-6.1	2804.
0.171	0.0214	7.966	73925.	9250.	3124.	0.		3513.	******	******	******	0.0	0.0	
0.871	342.11	6104.5	74059.	11741.	414.5	1776.0	T	0.230	346.5	0.653	0.817	-3.7	-6.1	2702.
0.170	0.0214	7.939	73906.	9309.	3184.	0.		3546.	******	******	******	0.0	0.0	
0.877	344.66	6124.1	74040.	10741.	408.9	1776.0	T	0.231	347.3	0.642	0.818	-3.7	-6.1	2687.
0.169	0.0214	7.910	73884.	9340.	3245.	0.		3577.	******	******	******	0.0	0.0	
0.883	347.19	6144.3	74020.	9741.	289.7	1776.0	T	0.287	250.0	0.453	0.797	-0.4	-0.4	204.
0.327	0.0307	10.645	74018.	6953.	3756.	0.		4869.	******	******	******	0.0	0.0	
0.965	370.94	6451.9	73712.	8741.	285.2	1776.0	T	0.289	250.0	0.445	0.797	-1.4	-1.4	707.
0.325	0.0306	10.637	73690.	6927.	3796.	0.		4919.	******	******	******	0.0	0.0	
0.988	377.66	6541.2	73623.	7741.	280.9	1776.0	T	0.290	250.0	0.436	0.797	-1.4	-1.4	681.
0.325	0.0306	10.635	73602.	6921.	3820.	0.		4966.	******	******	******	0.0	0.0	
1.013	384.54	6634.7	73529.	6741.	276.6	1776.0	T	0.292	250.0	0.428	0.797	-1.3	-1.3	656.
0.325	0.0305	10.633	73510.	6913.	3847.	0.		5010.	******	******	******	0.0	0.0	
1.038	391.56	6732.3	73431.	5741.	272.4	1776.0	T	0.293	250.0	0.420	0.797	-1.3	-1.3	633.
0.324	0.0305	10.630	73413.	6906.	3871.	0.		5050.	******	******	******	0.0	0.0	
1.065	398.73	6834.2	73330.	4741.	268.3	1776.0	T	0.295	250.0	0.412	0.797	-1.3	-1.3	612.
0.324	0.0305	10.628	73312.	6898.	3892.	0.		5086.	******	******	******	0.0	0.0	
1.092	406.04	6940.2	73224.	3741.	264.3	1776.0	T	0.296	250.0	0.405	0.797	-1.3	-1.3	592.
0.323	0.0304	10.625	73206.	6890.	3909.	0.		5118.	******	******	******	0.0	0.0	
1.120	413.48	7059.2	73114.	2741.	260.3	1776.0	T	0.296	250.0	0.397	0.798	-1.2	-1.3	573.
0.323	0.0304	10.622	73097.	6881.	3930.	0.		5149.	******	******	******	0.0	0.0	
1.149	421.05	7164.4	72999.	1741.	256.5	1776.0	T	0.298	250.0	0.390	0.798	-1.2	-1.3	554.
0.322	0.0303	10.619	72983.	6873.	3962.	0.		5182.	******	******	******	0.0	0.0	
1.179	428.78	7283.8	72880.	741.	252.7	1776.0	T	0.298	250.0	0.383	0.798	-1.2	-1.2	535.
0.322	0.0303	10.616	72865.	6863.	3993.	0.		5212.	******	******	******	0.0	0.0	
1.202	434.61	7375.8	72788.	0.	250.0	1776.0	T	0.299	250.0	0.378	0.798	-1.2	-1.2	523.
0.321	0.0303	10.614	72773.	6856.	4015.	0.		5230.	******	******	******	0.0	0.0	

LOITER FOR 0.500 HRS. FOR RESERVE FUEL TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	IAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	FUEL RATE (LB-HR)	ETAP PROP
CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW (LBS/HR)	BHP		THRUST (LBS)	CP	CT	J	VTIP (FPS)	ETAP
1.202	434.61	7375.8	72788.	0.	208.8	1833.1	P	0.374	202.8	0.315	0.780	4743.	1.000
0.461	0.0435	10.601	72788.	6866.	4743.	0.		6866.	******	******	******	0.0	1.000

1.302	434.61	7850.1	72314.	0.	208.8	1[illegible]	P	0.37[illegible]	208.8	0.315	0.780	4711.	1.000
0.458	0.0431	10.614	72314.	6813.	4711.			68[illegible]3.	***[illegible]**	******	******	0.0	1.000
1.402	434.61	8321.2	71842.	0.	207.8	1827.5	P	[illegible].369	207.8	0.314	0.780	4679.	1.000
0.459	0.0433	10.608	71842.	6773.	4679.	0.		6773.	******	******	******	0.0	1.000
1.502	434.61	8789.1	71375.	0.	206.8	1824.7	P	0.366	206.8	0.312	0.780	4648.	1.000
0.461	0.0435	10.602	71375.	6732.	4648.	0.		6732.	******	******	******	0.0	1.000
1.602	434.61	9253.9	70910.	0.	205.8	1821.9	P	0.364	205.8	0.311	0.779	4617.	1.000
0.462	0.0436	10.595	70910.	6693.	4617.	0.		6693.	******	******	******	0.0	1.000
1.702	434.61	9715.6	70448.	0.	205.8	1819.1	P	0.361	205.8	0.311	0.780	4586.	1.000
0.459	0.0433	10.608	70448.	6641.	4586.	0.		6641.	******	******	******	0.0	1.000
1.702	434.61	9715.6	70448.	0.	205.8	1819.1	P	0.361	205.8	0.311	0.780	4586.	1.000
0.459	0.0433	10.608	70448.	6641.	4586.	0.		6641.	******	******	******	0.0	1.000

TAKEOFF, HOVER, OR LAND AT T/W = 1.000 FOR 0.087 HRS.
VERTICAL RATE OF CLIMB = 0.0 FT/MIN TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	LETF	THRUST TO WEIGHT	FM	BHP	CT	VTIP (FPS)
1.202	434.61	9715.6	72788.	0.	0.0	2095.1	P	0.689	0.689	1.000	0.960			
1.218	434.61	10128.6	72375.	0.	0.0	2091.1	P	0.685	0.685	1.000	0.960			
1.234	434.61	10538.8	71965.	0.	0.0	2087.1	P	0.681	0.681	1.000	0.960			
1.249	434.61	10946.2	71557.	0.	0.0	2083.2	P	0.677	0.677	1.000	0.960			
1.265	434.61	11350.8	71153.	0.	0.0	2079.2	P	0.673	0.673	1.000	0.960			
1.281	434.61	11752.7	70751.	0.	0.0	2075.3	P	0.669	0.669	1.000	0.960			
1.290	434.61	11981.6	70522.	0.	0.0	2073.1	P	0.667	0.667	1.000	0.960			

TAXI FOR 0.033 HRS. AT GROUND IDLE ENGINE RATING TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	LETF
1.290	434.61	11981.6	70522.	0.	0.0	1417.0	T	0.067	0.0
1.323	434.61	12012.1	70491.	0.	0.0	1417.0	T	0.067	0.0

MISSION FUEL REQUIRED = 9672.14
RESERVE FUEL REQUIRED = 2339.94
TOTAL FUEL REQUIRED = 12012.08

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END OF SUCCESSFUL CASE

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                         V A S C O M P  II
      V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93

      THE FOLLOWING IS A CARD BY CARD REPRODUCTION OF THE INPUT DECK FOR THIS CASE

LOC.  CORRESPONDS TO LOCATION NUMBER GIVEN ON INPUT SHEET
NUM   STANDS FOR THE NUMBER OF SEQUENTIAL INPUT VALUES STARTING WITH LOC. (MAX. =5)
VAL   EQUALS VALUE FOR VARIABLE CORRESPONDING TO LOC.
VAL1         VALUE               CORRESPONDING TO LOC.+0001
VAL2         VALUE               CORRESPONDING TO LOC.+0002
      ETC.

  LOC.      NUM       VAL          VAL1         VAL2         VAL3         VAL4

    2        1         .0
WG = 0.700000E+05  WFA = 0.118927E+05  WFR = 0.120121E+05
WG = 0.700000E+05  WFA = 0.682529E+04  WFR = 0.106524E+05
WG = 0.754672E+05  WFA = 0.962225E+04  WFR = 0.113911E+05
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V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM   B-93

S I Z E D A T A THIS RUN CONVERGED IN 3 ITERATIONS

GROSS WEIGHT = 80166. LB

FUSELAGE			
LF	LENGTH	83.2	FT
WF	WIDTH	11.4	FT
SF	WETTED AREA	2496.	SQFT
WING			
AR	ASPECT RATIO	3.20	
SW	AREA	1068.9	SQFT
B	SPAN	58.5	FT
CBARW	GEOM. MEAN CHORD	18.3	FT
LAMBDA C/4	QUARTER CHORD SWEEP	35.0	DEG
LAMBDA	TAPER RATIO	0.230	
(T/C)R	ROOT THICKNESS	0.145	
(T/C)T	TIP THICKNESS	0.100	
WG/SW	WING LOADING	75.0	LB/SQFT
HOR. TAIL			
ARHT	ASPECT RATIO	3.30	
SHT	AREA	325.6	SQFT
BHT	SPAN	32.8	FT
CBARHT	MEAN CHORD	9.9	FT
(T/C)HT	THICKNESS / CHORD	0.100	
LTH	MOMENT ARM	36.0	FT
VERT. TAIL			
ARVT	ASPECT RATIO	1.50	
SVT	AREA	192.3	SQFT
BVT	SPAN	17.0	FT
CBARVT	MEAN CHORD	11.3	FT
(T/C)VT	THICKNESS / CHORD	0.100	
LTV	MOMENT ARM	32.5	FT
PRIMARY ENG. NACELLE			
LN	LENGTH	9.4	FT
DBARN	MEAN DIAMETER	2.8	FT
SN	WETTED AREA	337.2	SQRT
LIFT ENG. NACELLE			
LNG	LENGTH	0.0	FT
LLN	DEPTH	1.2	FT
DBARLN	MEAN DIAMETER	7.	FT
SLN	WETTED AREA	9.	SQFT

PROPELLER

NO PROPELLER ON THIS AIRCRAFT

V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

P A S S E N G E R S I Z I N G D A T A

	TOURIST	FIRST CLASS
NO. OF PASS.	0.	60.
NO. ABREAST	0.	5.
NO.OF AISLES	0.	1.
UNIT SEAT WIDTH	0. IN.	22. IN.
SEAT PITCH	0. IN.	36. IN.
AISLE WIDTH	0. IN.	18. IN.

NUMBER OF LAVATORIES	2.00	
GALLEY AREA	39.0 SQ. FT.	
CLOSET AREA	6.3 SQ. FT.	
CABIN DIAMETER	129.1 IN.	*** FIRST CLASS CRITICAL
BODY DIAMETER	137.4 IN.	*** FIRST CLASS CRITICAL

NOSE SECTION LENGTH	21.2 FT.
TAIL SECTION LENGTH	28.6 FT.
CONST. DIA. LENGTH	33.4 FT.
TOTAL FUSELAGE LENGTH	83.2 FT.

V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

W E I G H T S D A T A IN LBS

GLF		GUST LOAD FACTOR	2.654		
STRUCTURES GROUP					
	K8 WW	WING	5948.		
	K9 WHT	HOR. TAIL	1183.		
	K10 WVT	VERT. TAIL	715.		
	K11 WB	FUSELAGE	9832.		
	K12 WLG	LANDING GEAR	3447.		
	K13 WLES	LIFT ENGINE SECTION	0.		
	K14 WPES	PRIMARY ENGINE SECTION	1347.		
	DELTA WST	STRUCTURE WEIGHT INCREMENT	0.		
	WST	TOTAL STRUCTURE WEIGHT	22471.		
PROPULSION GROUP					
	K2 WR/P	ROTOR OR PROP	0.		
	K3 WDS	DRIVE SYSTEM	0.		
	K4 WEL	LIFT ENGINES	9386.		
	K5 WEP	PRIMARY ENGINES	3937.		
	K6 WLEI	LIFT ENGINE INSTALLATION	2347.		
	K7 WPEI	PRIMARY ENGINE INSTALLATION	1575.		
	K21 WFS	FUEL SYSTEM	832.		
	DELTA WP	PROPULSION GROUP WEIGHT INCREMENT	0.		
	WP	TOTAL PROPULSION GROUP WEIGHT	18078.		
FLIGHT CONTROLS GROUP					
	K15 WCC	COCKPIT CONTROLS	157.		
	K16 WUC	UPPER CONTROLS	0.		
	K17 WH	HYDRAULICS	0.		
	K18 WFW	FIXED WING CONTROLS	1202.		
	K19 WSAS	SAS	175.		
	K20 WTM	TILT MECHANISM	0.		
	DELTA WFC	CONTROL WEIGHT INCREMENT	500.		
	WFC	TOTAL CONTROL WEIGHT	2034.		
WFE		WEIGHT OF FIXED EQUIPMENT	11040.		
WE		WEIGHT EMPTY	53623.		
WFUL		FIXED USEFUL LOAD	1450.		
OWE		OPERATING WEIGHT EMPTY	55073.		
WPL		PAYLOAD	13200.		
(WF)A		FUEL	11893.	(WF)W	10973.
WG		GROSS WEIGHT	80166.		

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                         V A S C O M P  II
      V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93


 P R O P U L S I O N  D A T A
          PRIMARY PROPULSION CYCLE NO.   22.000
                  TURBOFAN   ENGINE

                    4.  ENGINES

              T*P            MAX. STANDARD S.L. STATIC THRUST       29160.     LB

              ENGINE SIZED FOR CRUISE AT VC = 466. KNOTS,
              HC = 30000. FT, TEMPERATURE = -47.98 DEG F.


          LIFT ENGINE CYCLE NO.   55.000
                  LIFT FAN      ENGINE
           4.  ENGINES IN  2. CLUSTERS
              T*L            MAX. STANDARD S.L. STATIC THRUST       75327.     LB

          ENGINE SIZED FOR TAKEOFF WITH T/W = 1.04.,
          100.0 PERCENT POWER,
          AUGMENTED BY PRIMARY PROPULSION OF  80.PER CENT

                  CRITICAL SIZING CONDITION IS  0.700 LIFT ENGINES INOPERATIVE
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V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

A E R O D Y N A M I C S D A T A

FE	TOTAL EFFECTIVE FLATPLATE AREA	19.489	SQFT
SWET	TOTAL WETTED AREA	5693.	SQFT
CBARF	MEAN SKIN FRICTION COEFF.	0.003424	

D R A G B R E A K D O W N IN SQFT

FEW	WING FE	6.923
FEF	FUSELAGE FE	6.131
FEVT	VERT. TAIL FE	1.268
FEHT	HOR. TAIL FE	2.191
FEN	PRIMARY ENG. NACELLE FE	1.906
FELN	LIFT ENG. NACELLE FE	0.0
DELTA FE	INCREMENTAL FE	1.069

A E R O D Y N A M I C C O E F F .

A1		0.83950	
A2		-0.13007	
A3		0.02221	
A4		0.09636	
A5		0.01176	
A6		0.98140	
A7		0.11831	
CL ALPHA	3-D LIFT SLOPE	3.72296	PER RADIAN
E	OSWALD FACTOR	0.84075	

V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

MISSION PERFORMANCE DATA

TAXI FOR 0.033 HRS. AT GROUND IDLE ENGINE RATING TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	LETF
0.0	0.0	0.0	80166.	0.	0.0	1417.0	T	0.067	0.021
0.033	0.0	130.8	80035.	0.	0.0	1417.0	T	0.067	0.021

TAKEOFF, HOVER, OR LAND AT T/W = 1.000 FOR 0.017 HRS.
VERTICAL RATE OF CLIMB = 0.0 FT/MIN TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	LETF	THRUST TO WEIGHT	FM	BHP	CT	VTIP (FPS)
0.033	0.0	130.8	80035.	0.	0.0	2165.2	P	0.757	0.757	1.000	0.960			
0.050	0.0	623.3	79543.	0.	0.0	2160.5	P	0.752	0.752	1.000	0.960			

CLIMB TO OPT. ALT. FOR NEXT CRUISE WITH MAXIMUM R/C AT MILITARY ENGINE RATING, MAXIMUM ALT. 50000. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	GAMMA (DEG)	THETA -F (DEG)	R/C (FPM)
0.050	0.0	623.3	79543.	0.	250.0	2377.5	W	1.000	250.0	0.378	0.794	7.3	7.7	3232.
0.055	1.28	687.0	79479.	1000.	253.7	2391.9	W	1.000	250.0	0.385	0.794	6.7	7.1	3019.
0.061	2.67	755.3	79411.	2000.	257.5	2407.0	W	1.000	250.0	0.392	0.794	6.7	7.1	3045.
0.066	4.07	823.0	79343.	3000.	261.3	2422.7	W	1.000	250.0	0.399	0.794	6.7	7.0	3071.
0.072	5.48	890.1	79276.	4000.	265.3	2438.2	W	1.000	250.0	0.407	0.794	6.6	7.0	3096.
0.077	6.90	956.6	79209.	5000.	269.3	2444.0	T	0.988	250.0	0.414	0.794	6.4	6.8	3057.
0.082	8.36	1023.3	79142.	6000.	273.4	2444.0	T	0.970	250.0	0.422	0.794	6.2	6.5	2980.
0.088	9.88	1090.3	79075.	7000.	277.7	2444.0	T	0.952	250.0	0.430	0.794	5.9	6.3	2903.
0.094	11.47	1157.8	79008.	8000.	282.0	2444.0	T	0.934	250.0	0.438	0.794	5.7	6.0	2824.
0.100	13.13	1225.8	78940.	9000.	286.4	2444.0	T	0.917	250.0	0.447	0.794	5.4	5.8	2743.
0.106	14.86	1294.5	78871.	10000.	290.9	2444.0	T	0.899	250.0	0.456	0.794	5.2	5.5	2661.
0.112	16.68	1363.9	78802.	11000.	322.1	2444.0	T	0.888	272.4	0.506	0.802	5.2	4.7	2944.
0.118	18.49	1425.8	78740.	12000.	324.9	2444.0	T	0.870	270.5	0.513	0.801	4.6	4.1	2634.
0.124	20.54	1493.6	78672.	13000.	327.9	2444.0	T	0.855	268.6	0.519	0.801	4.4	4.0	2544.
0.131	22.69	1562.2	78603.	14000.	330.8	2444.0	T	0.856	266.7	0.526	0.800	4.2	3.9	2452.
0.137	24.93	1631.9	78534.	15000.	333.8	2444.0	T	0.857	264.8	0.533	0.799	4.0	3.7	2361.
0.144	27.28	1702.7	78463.	16000.	336.9	2444.0	T	0.858	262.9	0.540	0.799	3.8	3.6	2267.
0.152	29.76	1774.7	78391.	17000.	340.0	2444.0	T	0.859	261.0	0.547	0.798	3.6	3.5	2175.
0.159	32.36	1848.1	78317.	18000.	343.1	2444.0	T	0.860	259.0	0.554	0.798	3.4	3.4	2080.
0.167	35.11	1923.1	78242.	19000.	346.3	2444.0	T	0.861	257.1	0.561	0.797	3.2	3.3	1985.
0.176	38.01	1999.9	78165.	20000.	349.6	2444.0	T	0.862	255.2	0.569	0.796	3.1	3.1	1889.
0.185	41.09	2078.7	78087.	21000.	352.8	2444.0	T	0.863	253.2	0.576	0.796	2.9	3.0	1793.
0.194	44.37	2159.7	78006.	22000.	356.2	2444.0	T	0.864	251.2	0.584	0.795	2.7	2.9	1695.
0.204	47.87	2243.4	77922.	23000	359.3	2444.0	T	0.865	249.1	0.592	0.794	2.5	2.9	1609.
0.214	51.59	2329.4	77836.	24000.	361.1	2444.0	T	0.866	246.0	0.597	0.793	2.5	2.9	1570.
0.225	55.43	2415.4	77750.	25000.	362.0	2444.0	T	0.867	242.3	0.601	0.792	2.4	3.0	1507.
0.236	59.43	2502.6	77663.	26000.	362.6	2444.0	T	0.869	238.5	0.605	0.791	2.2	3.0	1411.
0.243	63.71	2593.3	77572.	27000.	365.8	2444.0	T	0.871	236.3	0.613	0.790	1.9	2.7	1198.

0.262	68 80	2697.2	77468.	28000.	369.1	2444.0	T	0.872	234.2	0.621	0.789	1.7	2.7	1088.
0.277	74.46	2808.6	77356.	29000.	373.3	2444.0	T	0.874	232.6	0.631	0.788	1.4	2.5	954.
0.294	80.98	2932.1	77233.	30000.	378.5	2444.0	T	0.876	231.5	0.642	0.788	1.2	2.4	824.
0.315	88.64	3071.2	77094.	31000.	383.7	2444.0	T	0.878	230.4	0.654	0.787	1.1	2.2	716.
0.338	97.58	3227.1	76938.	32000.	388.9	2444.0	T	0.880	229.2	0.666	0.787	0.9	2.1	611.

CRUISE AT SPEED FOR 99 PER CENT BEST RANGE WITH HEADWIND OF 0.0 KNOTS TEMPERATURE = -55.1 DEG.F
CRUISE-CLIMB AT CONSTANT W/DELTA = 283989.

*** CAUTION - SPEED LIMITED BY THRUST AVAILABLE AT SPECIFIED POWER SETTING

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	SPEC. RANGE (NMPP)	ETAP PROP
0.338	97.58	3227.1	76938.	32000.	465.5	2340.0	T	0.802	274.4	0.797	0.803	.07760	1.000
0.343	100.00	3258.2	76907.	32009.	465.5	2340.0	T	0.802	274.3	0.797	0.803	.07763	1.000
0.397	125.00	3580.3	76585.	32099.	466.5	2340.0	T	0.802	274.4	0.799	0.803	.07794	1.000
0.450	150.00	3901.0	76264.	32190.	467.5	2340.0	T	0.802	274.6	0.801	0.803	.07825	1.000
0.504	175.00	4220.5	75944.	32280.	468.5	2340.0	T	0.802	274.7	0.803	0.803	.07856	1.000
0.557	200.00	4538.7	75626.	32371.	469.5	2340.0	T	0.802	274.8	0.805	0.804	.07887	1.000
0.610	225.00	4855.7	75309.	32461.	470.0	2340.0	T	0.802	274.6	0.806	0.804	.07918	1.000
0.664	250.00	5171.5	74993.	32551.	471.0	2340.0	T	0.802	274.7	0.808	0.804	.07949	1.000
0.717	275.00	5486.0	74679.	32641.	472.0	2340.0	T	0.803	274.9	0.810	0.804	.07979	1.000
0.770	300.00	5799.3	74365.	32732.	472.5	2340.0	T	0.803	274.7	0.811	0.804	.08010	1.000
0.775	302.45	5829.8	74335.	32741.	472.6	2340.0	T	0.803	274.7	0.811	0.804	.08013	1.000

DESCEND TO H = 0. FT. ,R = 434.00 N.MI. AT FLIGHT IDLE

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	GAMMA (DEG)	THETA -F (DEG)	R/S (FPM)
0.775	302.45	5829.7	74335.	32741.	275.5	1776.0	T	0.377	160.1	0.473	0.738	-13.8	-6.9	6666.
0.777	303.12	5836.2	74328.	31741.	302.6	1776.0	T	0.368	179.2	0.517	0.758	-10.8	-6.2	5768.
0.780	303.98	5843.9	74321.	30741.	327.7	1776.0	T	0.359	197.7	0.558	0.772	-9.5	-6.6	5499.
0.783	304.96	5852.1	74312.	29741.	350.9	1776.0	T	0.349	215.6	0.594	0.783	-8.6	-6.9	5316.
0.786	306.04	5860.8	74304.	28741.	371.0	1776.0	T	0.342	232.2	0.626	0.790	-7.1	-6.3	4663.
0.790	307.36	5870.7	74294.	27741.	389.1	1776.0	T	0.334	248.0	0.654	0.796	-6.7	-6.6	4592.
0.794	308.76	5880.8	74284.	26741.	404.2	1776.0	T	0.324	262.3	0.676	0.801	-5.8	-6.3	4160.
0.798	310.38	5892.0	74272.	25741.	416.3	1776.0	T	0.314	275.0	0.693	0.804	-5.2	-6.0	3810.
0.802	312.19	5904.2	74260.	24741.	426.3	1776.0	T	0.304	286.7	0.707	0.807	-5.0	-6.2	3753.
0.806	314.08	5916.6	74248.	23741.	434.4	1776.0	T	0.293	297.3	0.718	0.809	-4.8	-6.2	3683.
0.811	316.04	5929.3	74235.	22741.	439.5	1776.0	T	0.284	306.1	0.723	0.811	-4.4	-6.0	3392.
0.816	318.19	5943.1	74221.	21741.	443.5	1776.0	T	0.275	314.3	0.727	0.813	-4.4	-6.2	3458.
0.821	320.33	5956.6	74208.	20741.	445.5	1776.0	T	0.266	321.2	0.727	0.814	-4.2	-6.2	3329.
0.826	322.55	5970.8	74193.	19741.	445.6	1776.0	T	0.259	326.7	0.724	0.815	-4.0	-6.1	3178.
0.831	324.88	5985.7	74179.	18741.	444.6	1776.0	T	0.253	331.5	0.720	0.815	-4.0	-6.1	3146.
0.836	327.23	6000.9	74163.	17741.	442.6	1776.0	T	0.246	335.6	0.714	0.816	-4.0	-6.2	3096.
0.842	329.61	6016.5	74148.	16741.	439.5	1776.0	T	0.241	338.9	0.706	0.816	-3.9	-6.2	3026.
0.847	332.03	6032.6	74131.	15741.	435.4	1776.0	T	0.236	341.2	0.697	0.817	-3.8	-6.1	2908.
0.853	334.52	6049.6	74114.	14741.	430.1	1776.0	T	0.232	342.6	0.686	0.817	-3.7	-6.0	2794.
0.859	337.08	6067.6	74096.	13741.	425.0	1776.0	T	0.228	344.1	0.675	0.817	-3.7	-6.1	2798.
0.865	339.61	6085.9	74078.	12741.	420.2	1776.0	T	0.229	345.7	0.665	0.817	-3.8	-6.1	2804.
0.871	342.11	6104.5	74059.	11741.	414.5	1776.0	T	0.230	346.5	0.653	0.817	-3.7	-6.1	2702.
0.877	344.66	6124.1	74040.	10741.	408.9	1776.0	T	0.231	347.3	0.642	0.818	-3.7	-6.1	2687.
0.883	347.19	6144.3	74020.	9741.	289.7	1776.0	T	0.287	250.0	0.453	0.797	-0.4	-0.4	204.
0.965	370.94	6451.9	73712.	8741.	285.2	1776.0	T	0.289	250.0	0.445	0.797	-1.4	-1.4	707.
0.988	377.66	6541.2	73623.	7741.	280.9	1776.0	T	0.290	250.0	0.436	0.797	-1.4	-1.4	681.
1.013	384.54	6634.7	73529.	6741.	276.6	1776.0	T	0.292	250.0	0.428	0.797	-1.3	-1.3	656.
1.038	391.56	6732.3	73431.	5741.	272.4	1776.0	T	0.293	250.0	0.420	0.797	-1.3	-1.3	633.
1.065	398.73	6834.2	73330.	4741.	268.3	1776.0	T	0.295	250.0	0.412	0.797	-1.3	-1.3	612.
1.092	406.04	6940.2	73224.	3741.	264.3	1776.0	T	0.296	250.0	0.405	0.797	-1.3	-1.3	592.

1.120	413.48	7050.2	73114.	2741.	260.3	1776.0	T	0.296	250.0	0.397	0.798	-1.2	-1.3	573.
1.149	421.05	7164.4	72999.	1741.	256.5	1776.0	T	0.298	250.0	0.390	0.798	-1.2	-1.3	554.
1.179	428.78	7283.8	72880.	741.	252.7	1776.0	T	0.298	250.0	0.383	0.798	-1.2	-1.2	535.
1.202	434.61	7375.8	72788.	0.	250.0	1776.0	T	0.299	250.0	0.378	0.798	-1.2	-1.2	523.

LOITER FOR 0.500 HRS. FOR RESERVE FUEL TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	FUEL RATE (LB-HR)	ETAP PROP
1.202	434.61	7375.8	72788.	0.	208.8	1833.1	P	0.374	208.8	0.315	0.780	4743.	1.000
1.302	434.61	7850.1	72314.	0.	208.8	1830.3	P	0.371	208.8	0.315	0.780	4711.	1.000
1.402	434.61	8321.2	71842.	0.	207.8	1827.5	P	0.369	207.8	0.314	0.780	4679	1.000
1.502	434.61	8789.1	71375.	0.	206.8	1824.7	P	0.366	206.8	0.312	0.780	4648.	1.000
1.602	434.61	9253.9	70910.	0.	205.8	1821.9	P	0.364	205.8	0.311	0.779	4617.	1.000
1.702	434.61	9715.6	70448.	0.	205.8	1819.1	P	0.361	205.8	0.311	0.780	4586.	1.000
1.702	434.61	9715.6	70448.	0.	205.8	1819.1	P	0.361	205.8	0.311	0.780	4586.	1 000

TAKEOFF, HOVER, OR LAND AT T/W = 1.000 FOR 0.087 HRS.
VERTICAL RATE OF CLIMB = 0.0 FT/MIN TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	LETF	THRUST TO WEIGHT	FM	BHP	CT	VTIP (FPS)
1.202	434.61	9715.6	72788.	0.	0.0	2095.1	P	0.689	0.689	1.000	0.960			
1.218	434.61	10128.6	72375.	0.	0.0	2091.1	P	0.685	0.685	1.000	0.960			
1.234	434.61	10538.8	71965.	0.	0.0	2087.1	P	0.681	0.681	1.000	0.960			
1.249	434.61	10946.2	71557.	0.	0.0	2083.2	P	0.677	0.677	1.000	0.960			
1.265	434.61	11350.8	71153.	0.	0.0	2079.2	P	0.673	0.673	1.000	0.960			
1.281	434.61	11752.7	70751.	0.	0.0	2075.3	P	0.669	0.669	1.000	0.960			
1.290	434.61	11981.6	70522.	0.	0.0	2073.1	P	0.667	0.667	1.000	0.960			

TAXI FOR 0.033 HRS. AT GROUND IDLE ENGINE RATING TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	LETF
1.290	434.61	11981.6	70522.	0.	0.0	1417.0	T	0.067	0.0
1.323	434.61	12012.1	70491.	0.	0.0	1417.0	T	0.067	0.0

MISSION FUEL REQUIRED = 9672.14
RESERVE FUEL REQUIRED = 2339.94
TOTAL FUEL REQUIRED = 12012.08

****

END OF SUCCESSFUL CASE

****

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                      V A S C O M P  II
     V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93

   THE FOLLOWING IS A CARD BY CARD REPRODUCTION OF THE INPUT DECK FOR THIS CASE

LOC.  CORRESPONDS TO LOCATION NUMBER GIVEN ON INPUT SHEET
NUM   STANDS FOR THE NUMBER OF SEQUENTIAL INPUT VALUES STARTING WITH LOC. (MAX. =5)
VAL   EQUALS VALUE FOR VARIABLE CORRESPONDING TO LOC.
VAL1         VALUE             CORRESPONDING TO LOC.+0001
VAL2         VALUE             CORRESPONDING TO LOC.+0002
      ETC.

  LOC.      NUM      VAL           VAL1          VAL2          VAL3          VAL4

     1        1      .0
WG = 0.700000E+05  WFA = 0.118927E+05  WFR = 0 120121E+05
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                          V A S C O M P  II
 V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93

S I Z E  D A T A  THIS RUN CONVERGED IN  0 ITERATIONS

                    GROSS WEIGHT =  70000.  LB

     FUSELAGE
         LF            LENGTH                        83.2    FT
         WF            WIDTH                         11.4    FT
         SF            WETTED AREA                 2496.     SQFT

     WING
         AR            ASPECT RATIO                   3.20
         SW            AREA                         933.3    SQFT
         B             SPAN                          54.7    FT
         CBARW         GEOM. MEAN CHORD              17.1    FT
         LAMBDA C/4    QUARTER CHORD SWEEP           35.0    DEG
         LAMBDA        TAPER RATIO                  0.230
         (T/C)R        ROOT THICKNESS               0.145
         (T/C)T        TIP  THICKNESS               0.100
         WG/SW         WING LOADING                  75.0    LB/SQFT

     HOR. TAIL
         ARHT          ASPECT RATIO                   3.30
         SHT           AREA                         265.7    SQFT
         BHT           SPAN                          29.6    FT
         CBARHT        MEAN CHORD                     9.0    FT
         (T/C)HT       THICKNESS / CHORD            0.100
         LTH           MOMENT ARM                    36.0    FT

     VERT. TAIL
         ARVT          ASPECT RATIO                   1.50
         SVT           AREA                         156.9    SQFT
         BVT           SPAN                          15.3    FT
         CBARVT        MEAN CHORD                    10.2    FT
         (T/C)VT       THICKNESS / CHORD            0.100
         LTV           MOMENT ARM                    32.5    FT

     PRIMARY ENG. NACELLE
         LN            LENGTH                         8.9    FT
         DBARN         MEAN DIAMETER                  2.7    FT
         SN            WETTED AREA                  297.7    SQRT

     LIFT ENG. NACELLE
         LNG           LENGTH                         0.0    FT
         LLN           DEPTH                          1.1    FT
         DBARLN        MEAN DIAMETER                  7.     FT
         SLN           WETTED AREA                    0.     SQFT

     PROPELLER

                  NO PROPELLER ON THIS AIRCRAFT
```

V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

P A S S E N G E R S I Z I N G D A T A

	TOURIST	FIRST CLASS
NO. OF PASS.	0.	60.
NO. ABREAST	0.	5.
NO.OF AISLES	0.	1.
UNIT SEAT WIDTH	0. IN.	22. IN.
SEAT PITCH	0. IN.	36. IN.
AISLE WIDTH	0. IN.	18. IN.

NUMBER OF LAVATORIES	2.00	
GALLEY AREA	39.0 SQ. FT.	
CLOSET AREA	6.3 SQ. FT.	
CABIN DIAMETER	129.1 IN.	*** FIRST CLASS CRITICAL
BODY DIAMETER	137.4 IN.	*** FIRST CLASS CRITICAL

NOSE SECTION LENGTH	21.2 FT.
TAIL SECTION LENGTH	28.6 FT.
CONST. DIA. LENGTH	33.4 FT.
TOTAL FUSELAGE LENGTH	83.2 FT.

V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM   B-93

W E I G H T S   D A T A   IN LBS

GLF	GUST LOAD FACTOR	2.666
STRUCTURES GROUP		
K8 WW	WING	5049.
K9 WHT	HOR. TAIL	985.
K10 WVT	VERT. TAIL	586.
K11 WB	FUSELAGE	9552.
K12 WLG	LANDING GEAR	3010.
K13 WLES	LIFT ENGINE SECTION	0.
K14 WPES	PRIMARY ENGINE SECTION	1223.
DELTA WST	STRUCTURE WEIGHT INCREMENT	0.
WST	TOTAL STRUCTURE WEIGHT	20406.
PROPULSION GROUP		
K2 WR/P	ROTOR OR PROP	0.
K3 WDS	DRIVE SYSTEM	0.
K4 WEL	LIFT ENGINES	7778.
K5 WEP	PRIMARY ENGINES	3576.
K6 WLEI	LIFT ENGINE INSTALLATION	1944.
K7 WPEI	PRIMARY ENGINE INSTALLATION	1430.
K21 WFS	FUEL SYSTEM	478.
DELTA WP	PROPULSION GROUP WEIGHT INCREMENT	0.
WP	TOTAL PROPULSION GROUP WEIGHT	15206.
FLIGHT CONTROLS GROUP		
K15 WCC	COCKPIT CONTROLS	148.
K16 WUC	UPPER CONTROLS	0.
K17 WH	HYDRAULICS	0.
K18 WFW	FIXED WING CONTROLS	1050.
K19 WSAS	SAS	175.
K20 WTM	TILT MECHANISM	0.
DELTA WFC	CONTROL WEIGHT INCREMENT	500.
WFC	TOTAL CONTROL WEIGHT	1873.
WFE	WEIGHT OF FIXED EQUIPMENT	11040.
WE	WEIGHT EMPTY	48525.
WFUL	FIXED USEFUL LOAD	1450.
OWE	OPERATING WEIGHT EMPTY	49975.
WPL	PAYLOAD	13200.
(WF)A	FUEL	6825. (WF)W 6825.
WG	GROSS WEIGHT	70000.

```
                         V A S C O M P  II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93

P R O P U L S I O N   D A T A
        PRIMARY PROPULSION CYCLE NO.   22.000
                TURBOFAN   ENGINE

                 4.  ENGINES

            T*P             MAX. STANDARD S.L. STATIC THRUST      26194.     LB

            ENGINE SIZED FOR CRUISE AT VC = 466. KNOTS,
            HC = 30000. FT, TEMPERATURE = -47.98 DEG F.


        LIFT ENGINE CYCLE NO.   55.000
                LIFT FAN       ENGINE
         4.  ENGINES IN  2. CLUSTERS
            T*L             MAX. STANDARD S.L. STATIC THRUST      65080.     LB

        ENGINE SIZED FOR TAKEOFF WITH T/W = 1.04.,
        100.0 PERCENT POWER,
        AUGMENTED BY PRIMARY PROPULSION OF  80.PER CENT

                CRITICAL SIZING CONDITION IS  0.700 LIFT ENGINES INOPERATIVE
```

V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

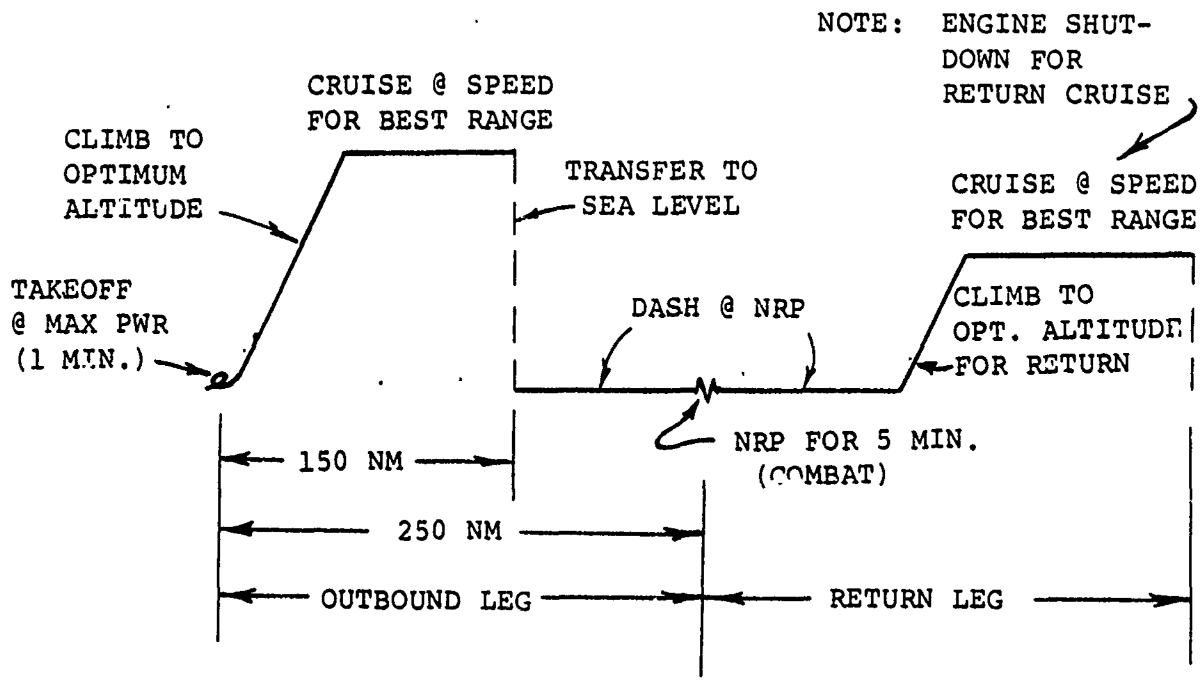
```
A E R O D Y N A M I C S   D A T A
          FE          TOTAL EFFECTIVE FLATPLATE AREA        17.739    SQFT
          SWET        TOTAL WETTED AREA                      5214.    SQFT
          CBARF       MEAN SKIN FRICTION COEFF.           0.003402

D R A G   B R E A K D O W N       IN  SQFT
          FEW         WING FE                                6.107
          FEF         FUSELAGE FE                            6.131
          FEVT        VERT. TAIL FE                          1.051
          FEHT        HOR.  TAIL FE                          1.816
          FEN         PRIMARY ENG. NACELLE FE                1.700
          FELN        LIFT ENG. NACELLE FE                   0.0
          DELTA FE    INCREMENTAL FE                         0.933

A E R O D Y N A M I C   C O E F F .
          A1                                               0.84039
          A2                                              -0.13007
          A3                                               0.02205
          A4                                               0.09594
          A5                                               0.01246
          A6                                               0.99140
          A7                                               0.11831
          CL ALPHA    3-D LIFT SLOPE                       3.72296    PER RADIAN
          E           OSWALD   FACTOR                      0.84075
```

7.3.2 High-Performance COIN Turboprop

Only those inputs which are of prime interest are discussed below. A copy of the output follows the input. The design mission profile is illustrated below. The case was set up so that following the sizing the program would calculate the specific excess power (P_s) of the airplane at a given altitude and airspeed.



VASCOMP II - DESCRIPTION OF SAMPLE CASE 2

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS	
General Information Sheet				
OPTIND	0001	1.0	Sizing run	
TNIRPK	0002	1.0	Print indicator-optional print	
DRGIND	0003	0.0	Program calculates compressibility drag	
OSWIND	0004	1.0	Program calculates induced drag factor	
FDMIND	0006	0.0	Size fuselage for passenger requirements	
WDMIND	0007	2.0	Wing not dependent on propeller size	
HTIND	0008	2.0	Input tail volume coefficients	
VTIND	0009	2.0		
FIXIND	0010	0.0	Program sizes engines	
ENGIND	0011	0.0	Turboshaft primary engines	
LFTIND	0013	0.0	No lift engines specified	
WG_o	0014	20000.	1st guess at design gross weight	
h_o	0015	0.	Start altitude	Normally 0. except for partial mission analysis
R_o	0016	0.	Starting range	
t_o	0017	0.	Starting time	
HOPTIN	0018	1.0	Cruise desired at optimum altitude	
VLMIND	0019	0.0	Airspeed limited to 250 knots EAS at altitude of 10,000 ft or less	
M_{mo}	0020	0.667	Maximum operating mach number	
V_{mo}	0021	400.	Maximum operating EAS knots	
V_{DIVE}	0022	450.	Design dive speed	

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS	
M_{LF}	0023	7.33	Maneuver load factor	
K_1	0024	1.0	Factor on mission fuel burned to give reserve fuel, i.e. 1.1 would give 10% reserve	
SW_F	0025	0.	Fixed fuel increment for reserves or other use	
K_{FF}	0026	1.05	Use nominal engine fuel	
SGTIND	0027	2.	TAKEOFF	
	0028	3.	CLIMB	
	0029	4.	CRUISE	
	0030	9.	TRANSFER ALTITUDE	
	0031	4.	CRUISE	SEQUENCE
	0032	2.	TAKEOFF	OR
	0033	4.	CRUISE	DESIGN
	0034	3.	CLIMB	MISSION
	0035	4.	CRUISE	
	0036	0.	END OF MISSION	
	0037	9.	TRANSFER ALTITUDE	
	0038	3.	CLIMB	
	0039	100.	END OF CASE	

Aircraft Dimensional Sheet

1_W	0103	2.0	Wing incidence angle to fuselage horizontal datum (degrees)
$(L/_C)_R$	0104	.17	Root thickness-chord ratio
$(L/_C)_T$	0105	.13	Tip thickness-chord ratio
$W_G/_S$	0106	50.	Wing loading at design gross weight
$\Lambda c/4$	0107	0.	Quarter chord mean sweep angle, degrees
λ	0108	.5	Taper ratio (tip chord/root chord)
AR_{HT}	0109	4.65	Horizontal tail aspect ratio
a_H	0110	0.405	Vertical position of horizontal tail on vertical tail, spans above vertical tail root chord. Valve is 0. on or below root chord, 1.0 for "T" tail

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
l_{TH}	0111	23.	Horizontal tail arm, FT
(t/c)HT	0112	.12	Horizontal tail mean thickness/ chord ratio
λ_H	0114	.4	Horizontal tail taper ratio
S_{HT}	0115	128.	Area of horizontal tail
Γ	0116	.075	Prop blade attachment distance from centerline of hob (fraction of prop radius)
Y_{CL}	0117	8.3	Clearance from inboard prop tip to inboard prop tip across fuse- lage (feet)
ζ_1	0118	1.0	Prop over prop overlap (fraction of radius)
ζ_2	0119	-2.0	Prop over wing tip overlap (frac- tion of radius)
$\Delta S_{WET}/S_W$	0120	0.	Increment in wetted are a for landing gear or other protusions
l_f	0122	46.	Fuselage length (feet)
l_{RW}	0126	0.	Length of ramp well or other strengthened fuselage portion (e.g., rear engine attachments). Used to compute fuselage weight penalty.
S_F	0127	530.	Fuselage wetted area (square feet)
ω_F	0128	4.3	Width of fuselage (feet)
AR_{VT}	0129	1.8	Vertical tail aspect ratio
l_{TV}	0130	22.	Vertical tail arm
(t/c)VT	0131	.12	Vertical tail thickness/chord ratio
λ_V	0133	.3	Vertical tail taper ratio
S_{VT}	0134	90.	Area of vertical tail

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
Y_{mg}	0135	.29	Spanwise distance of landing gear from mean spanwise distance
Y_p	0136	.29	of cruise engine from wing root in semispans. Used in wing relief term.

Aircraft Propulsion Information Required When Using Turboshaft Engines - Primary Engine

η_pIND	0200	2.0	Program calculates prop performance
Cycle No.	0201	4.	Cruise engine selection
SHP_p^*	0202	10000.	Maximum static sea level horsepower
N_p	0204	2.	Number of cruise engines
η_T	0206	.98	Transmission efficiency
h_{TO}	0207	0.	Takeoff pressure altitude for engine sizing
N_R	0223	2.	Number of rotors
V_{TIP}	0224	1013.5	Prop tip speed
DIA	0226	11.5	Prop diameter
AF	0228	125.	Activity factor per blade
BLDN	0229	4.0	Number of blades
C_{L_i}	0230	.46	Induced lift coefficient of wing
XMSNIND	0257	0.0	Size transmission at specified fraction of installed power
SHP_{XM}/SHP^*	0258	0.9	Size transmission at 90% installed power
ΔSHP_{ACC}	0259	0.0	No accessory horsepower added
SHP_E/SHP^*	0260	1.0	Engines sized at 100% power
$V_{R/C}$	0261	0.0	No vertical rate of climb specified for engine sizing

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
$K_{R/C}$	0262	2.0	Constant used to calculate additional horsepower necessary to climb at the specified vertical rate of climb. This value is based on momentum theory, and is used in the following equation: $\Delta SHP_{R/C} = \frac{(\text{Gross Weight})\ V_{R/C}}{33000.\ x\ K_{R/C}}$

Aircraft Aerodynamics Information Sheet

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
ΔC_D	0305	.01	Profile drag increment
Δfe FT^2	0307	7.0	Increment in equivalent flat plat area parasite drag of fuselage (ft^2)
No. of Pairs in Table	0308	2.0	Number of C_L-C_{DWi} Pairs in locations 317-330 and 335-342
K_W	0312	1.0	Wing multiplicative drag factor
C_{L1}	0317	0.0	Wing lift coefficient
C_{L2}	0318	0.4	
$(R_e/l)_i$	0330	$.215\times10^6$	Mean Reynolds number per foot for mission
$C_{l\alpha}$ RAD^{-1}	0331	6.28	Two dimensional wing lift coefficient slope
α_{LO} DEG.	0332	-1.0	Angle of attack where the lift equals zero
$(X/c)_{ps}$	0333	0.35	Position of peak suction location on wing
$(X/c)_{max_{c/c}}$	0334	.4	Position of maximum thickness on wing
$C_{DWi}(1)$	0335	0.	Wing induced drag coefficient
$C_{DWi}(2)$	0336	0.	

Aircraft Weight Information Sheet

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
W_{FE}LBS	0401	4000.	Weight of fixed equipment, in LBS.

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
W_{FUL} LBS	0402	550.	Weight of fixed useful load in LBS.
W_{PL} LBS	0403	5000.	Weight of payload in LBS.
K_{CC}	0404	0.	Cockpit controls weight factor
K_{FW}	0405	.024	Fixed wing controls weight factor
K_{H}	0406	0.	Constant for flight control hydraulics
K_{SAS}	0407	0.	Stability augmentation system (SAS) weight factor, usually in range of 20-100 LBS
K_{TM}	0408	0.0	Tilt mechanism weight factor
K_{UC}	0409	.2	Upper control weight factor
ΔW_{P}	0418	75.	Incremental propulsion group weight
ΔW_{ST}	0419	350.	Structures group incremental weight, in LBS
K_{LG}	0422	.05	Landing gear weight factor, percentage of gross weight
K_{MG}	0423	.8	Main landing gear weight factor
K_{TL}	0424	1.0	Tail load factor
K_{WW}	0426	205.	Detailed wing weight factor, adjusts the constant 220 in $W_W = 220a\ (k)^{.582}$ depending on the complexity of the control surfaces
K_{Y}	0427	.16	Pitch radius of gyration, feet
K_{Z}	0428	.24	Yaw radius of gyration, feet
K_{PES}	0429	.55	Primary engine section factor
K_{8}	0433	.9	Wing weight multiplicative factor

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
K_{DS}	C453	300.	Drive system weights constant
K_{FS}	0454	.33	Fuel system weights factor
K_{PEI}	0456	.3	Primary engine weight factor

Takeoff, Hover and Landing Information Sheet

TOLIND	0601 0602	3. 3.	Takeoff and land sharing equal fraction of thrust from primary ard lift engines
ATMIND	0611	0.	Takeoff standard day
ATMIND	0612	0.	Landing standard day
PEHF	0621	1.0	Takeoff engine fractional power = 1.0
PEHF	0622	.714	Engine fractonal power = .714
Δt_H	0661	.0167	Takeoff compute in 1 minute increments
Δt_H	0662	.0167	Landing compute in 1 minute increments
N_{II}/N_{IIMAX}	0671	1.0	Power turbine speed ratio - takeoff
N_{II}/N_{IIMAX}	0672	1.0	Power turbine speed ratio - land
t_H	0681	.0167	Takeoff in 1 minute
t_H	0682	.0833	Landing in 5.0 minutes
$V_{R/C}$	2321 2322	0.0 0.0	} No vertical rate of climb specified

Climb Information Sheet

CLMIND	0691 0692 0693	1.0 1.0 4.0	Climb at speed for max. R/C Climb at speed for max. R/C Climb at constant TAS
TAS	0703	300.	Climb at constant TAS = 300 knots

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
ATMIND	0711	0.	
	0712	0.	Standard atmosphere
	0713	0.	
Δh	0721	1000.	Print climb data in specified intervals
	0722	1000.	
	0723	20.	
$h_{MAX}FT$	0741	50000.	The airplane will climb to altitude for minimum fuel consumed during climb and cruise so long as the altitude is below 50,000 ft.
	0742	50000.	
	0743	1020.	
POWIND	0751	1.0	Climb at mil power
	0752	1.0	
	0753	0.0	Climb at maximum power
θ_{MAX}	0761	40.	
	0762	40.	Maximum cabin angle, degrees
	0763	40.	
N_{II}/N_{IIMAX}	0771	1.0	
	0772	1.0	Power turbine speed ratio
	0773	1.0	
Δn_{CLIMB}	0791	0.0	
	0792	0.0	Incremental normal load factor
	0793	2.0	

Cruise Information Sheet

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
CRSIND	0801	3.0	
	0802	1.0	Cruise indicator
	0803	1.0	
	0809	3.0	
ATMIND	0821	0.0	
	0822	0.0	Cruise @ standard day
	0823	0.0	
	0824	0.0	
ΔR	0831	20.0	
	0832	20.0	Increment for calculations
	0833	20.0	
	0834	20.0	
R_{MAX}	0851	150.	
	0852	250.	Range at end of cruise calculations.
	0853	350.	
	0854	500.	

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
POWIND	0862	2.0	} Cruise limited by normal power
	0863	2.0	
$N_{PSD_{CR}}$	0871	0.0	
	0872	0.0	Number of cruise engines inoperative during cruise
	0873	0.0	
	0874	1.0	
N_{II}/N_{IIMAX}	0881	0.7	
	0882	1.0	} Power turbine operating ratio
	0883	0.7	
	0884	1.0	
Transfer Altitude Sheet			
h_{final}	1111	0.0	Transfer aircraft to specified altitude
	1112	1000.0	
Primary Engine Data Information			
WDTIND	1201	1.0	Fuel flow cutoff
N1IND	1202	0.0	No gas generator cutoff
N1θIND	1203	0.0	No referred gas generator cutoff
N2IND	1204	2.0	Non-optimum power turbine variation
QIND	1205	0.0	No torque cutoff
RNOIND	1206	0.0	No Reynolds No. correction
$\dot{W}_{MAX}/\dot{W}^*$	1220	.906	Fuel flow cutoff at 90.6% of maximum sea level fuel flow
N_{IIMAX}/N_{II}^*	1223	.888	Power turbine cutoff at 88.8% of maximum sea level turbine power
Run 2			
η_{PIND}	0200	0.0	Input efficiency values
XMSNIND	0257	1.0	Transmission sized for either hover or cruise power required (the most critical condition is chosen)

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
SHP_{XM}/SHP^*	0258	0.9	Transmission sized at 90% of chosen power required
η_{P2}	0232	.93	Input hover efficiency
η_{P3}	0233	.93	Input climb efficiency
η_{P5}	0234	.93	Input descent efficiency
No. of Pairs in η_P Table	0245	2.0	Number of Mach number vs. Cruise efficiency pairs
Values of M	0235 0247	0.0 0.85	} Values of Cruise Efficiencies

The following inputs for transmission sizing are necessary to determine the power required for takeoff:

h_{TO}	0207	0.0	Takeoff altitude
n	0208	.631	Takeoff T/W
$\Delta T_{in_{TO}}$	0209	0.0	Standard atmosphere for takeoff
$N_{II}/N_{IIMAX_{TO}}$	0210	1.0	Power turbine referred operating speed for takeoff

The following inputs for transmission sizing are necessary to determine the power required for cruise:

h_C	0214	0.0	Cruise altitude
V_C	0215	225.0	Cruise velocity in knots
$\Delta T_{in_{CR}}$	0216	0.0	Standard atmosphere for cruise
$N_{II}/N_{IIMAX_{CR}}$	0217	1.0	Power turbine referred operating speed for takeoff

End of Data

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THE FOLLOWING IS A CARD BY CARD REPRODUCTION OF THE INPUT DECK FOR THIS CASE

LOC. CORRESPONDS TO LOCATION NUMBER GIVEN ON INPUT SHEET
NUM STANDS FOR THE NUMBER OF SEQUENTIAL INPUT VALUES STARTING WITH LOC. (MAX. =5)
VAL EQUALS VALUE FOR VARIABLE CORRESPONDING TO LOC.
VAL1 VALUE CORRESPONDING TO LOC.+0001
VAL2 VALUE CORRESPONDING TO LOC.+0002
ETC.

LOC.	NUM	VAL	VAL1	VAL2	VAL3	VAL4
1301	3	4.0000	.76200E-01	107.00		
1305	5	1975.0	1948.0	2610.0	2726.0	2900.0
1310	5	5.0000	1650.0	2000.0	2600.0	3200.0
1315	1	3910.0				
1319	5	6.0000	.0	.20000	.40000	.60000
1324	5	.80000	1.0000	-.35500	-.33500	-.25000
1329	5	-.19000	-.12500	.0	.80000E-01	.11000
1334	5	.16000	.24500	.34000	.46000	.70500
1339	5	.73500	.80500	.94000	1.0850	1.3250
1344	5	1.2600	1.3050	1.4250	1.6300	1.9000
1349	5	2.3000	1.7200	1.7850	1.9800	2.3100
1354	2	2.9150	3.4950			
1374	5	5.0000	1650.0	2000.0	2600.0	3200.0
1379	1	3910.0				
1383	5	6.0000	.0	.20000	.40000	.60000
1388	5	.80000	1.0000	-.25000E-01	-.15000E-01	.50000E-02
1393	5	.29000E-01	.55000E-01	.85000E-01	.11000	.12000
1398	5	.13900	.16000	.17900	.20500	.32100
1403	5	.33000	.35000	.38000	.42000	.46100
1408	5	.52000	.52500	.56100	.62900	.70500
1413	5	.79000	.74500	.75000	.85000	.97000
1418	2	1.1040	1.2480			
1438	5	6.0000	1300.0	1480.0	2000.0	2600.0
1443	2	3120.0	3510.0			
1447	5	6.0000	.0	.20000	.40000	.60000
1452	5	.80000	1.0000	.52000	.51900	.51800
1457	5	.51700	.51600	.51500	.59600	.59400
1462	5	.59300	.58800	.58500	.58100	.80100
1467	5	.79900	.79500	.78800	.77800	.76500
1472	5	1.0000	.99500	.99100	.98200	.96500
1477	5	.94400	1.1500	1.1460	1.1410	1.1280
1482	5	1.1070	1.0840	1.2550	1.2500	1.2450
1487	3	1.2300	1.2050	1.1800		
1502	5	5.0000	1450.0	2000.0	2600.0	3200.0
1507	1	3910.0				
1511	5	6.0000	.0	.20000	.40000	.60000
1516	5	.80000	1.0000	.18000	.22500	.30000
1521	5	.40000	.51000	.61500	.57500	.60200
1526	5	.65000	.73700	.83700	.93400	.89000
1531	5	.91000	.94200	1.0110	1.0980	1.1870
1536	5	1.0840	1.0990	1.1290	1.1860	1.2600
1541	5	1.3460	1.2180	1.2340	1.2520	1.2950

1546	2	1.3600	1.4250			
1	5	1.0000	1.0000	.0	1.0000	1.0000
6	5	.0	2.0000	2.0000	2.0000	.0
11	1	.0				
13	5	.0	20000.	.0	.0	.0
18	5	1.0000	.0	.66700	400.00	450.00
23	5	7.3300	1.0000	.0	1.0500	2.0000
28	5	3.0000	4.0000	9.0000	4.0000	2.0000
33	5	4.0000	3.0000	4.0000	.0	9.0000
38	2	3.0000	100.00			
103	5	2.0000	.17000	.13000	50.000	.0
108	5	.50000	4.6500	.40500	23.000	.12000
114	5	.40000	128.00	.75000E-01	8.3000	1.0000
119	2	-2.0000	.0			
122	1	46.000				
126	5	.0	530.00	4.3000	1.8000	22.000
131	1	.12000				
133	4	.30000	90.000	.29000	.29000	
201	2	4.0000	10000.			
204	1	2.0000				
206	1	.98000				
210	1	1.0000				
223	2	2.0000	1013.5			
226	1	11.500				
200	1	2.0000				
214	4	.0	225.00	.0	1.0000	
228	3	125.00	4.0000	.46000		
257	5	.0	.90000	.0	1.0000	.0
262	1	2.0000				
305	1	.10000E-01				
307	2	7.0000	2.0000			
312	1	1.0000				
317	2	.0	4.0000			
330	5	.21500E+06	6.2800	-1.0000	.35000	.40000
335	2	.0	.0			
401	5	4000.0	550.00	5000.0	.0	.24000E-01
406	4	.0	.0	.0	.20000	
418	3	75.000	350.00	165.00		
422	3	.50000E-01	.80000	1.0000		
426	4	205.00	.16000	.24000	.55000	
433	1	.90000				
453	2	300.00	.33000			
456	3	.30000	15.500	1.0000		
601	2	3.0000	3.0000			
611	2	.0	.0			
621	2	1.0000	.71400			
661	2	.16670E-01	.16670E-01			
671	2	1.0000	1.0000			
681	2	.16670E-01	.83300E-01			
2321	2	.0	.0			
691	3	1.0000	1.0000	4.0000		
703	1	300.00				
711	3	.0	.0	.0		
721	3	1000.0	1000.0	20.000		
741	3	50000.	50000.	1020.0		
751	3	1.0000	1.0000	.0		
761	3	40.000	40.000	40.000		
771	3	1.0000	1.0000	1.0000		
791	3	.0	.0	2.0000		
801	4	3.0000	1.0000	1.0000	3.0000	

```
   821     4     .0          .0          .0          .0
   831     4     20.000      20.000      20.000      20.000
   851     4     150.00      250.00      350.00      500.00
   862     2     2.0000      2.0000
   871     4     .0          .0          .0          1.0000
   881     4     .70000      1.0000      1.0000      .70000
  1111     2     .0          1000.0
  1201     5     1.0000      .0          .0          2.0000      .0
  1206     1     .0
  1220     1     .90600
  1223     1     .88800
WG = 0.200000E+05  WFA = 0.0           WFR = 0.0
WG = 0.200000E+05  WFA = -.109915E+03  WFR = 0.343686E+04
WG = 0.250668E+05  WFA = 0.275970E+04  WFR = 0.374829E+04
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SAMPLE CASE NO.2  RUN '   -  HIGH PERFORMANCE COIN TURBOPROP                PAGE   2

                                 V A S C O M P  II
          V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM     B-93

   S I Z E   D A T A   THIS RUN CONVERGED IN  3 ITERATIONS

                              GROSS WEIGHT =  27025.  LB

        FUSELAGE
           LF            LENGTH
           WF            WIDTH                                 46.0     FT
           SF            WETTED AREA                            4.3     FT
                                                              530.      SQFT
        WING
           AR            ASPECT RATIO
           SW            AREA                                   5.46
           B             SPAN                                 540.5     SQFT
           CBARW         GEOM. MEAN CHORD                      54.3     FT
           LAMBDA C/4    QUARTER CHORD SWEEP                   10.0     FT
           LAMBDA        TAPER RATIO                            0.0     DEG
           (T/C)R        ROOT THICKNESS                         0.500
           (T/C)T        TIP  THICKNESS                         0.170
           WG/SW         WING LOADING                           0.130
           C BAR / D     MEAN CHORD / PROP. DIA.               50.0     LB/SQFT
                                                                0.866
        HOR. TAIL
           ARHT          ASPECT RATIO
           SHT           AREA                                   4.65
           BHT           SPAN                                 128.0     SQFT
           CBARHT        MEAN CHORD                            24.4     FT
           (T/C)HT       THICKNESS / CHORD                      5.2     FT
                                                                0.120
        VERT. TAIL
           ARVT          ASPECT RATIO
           SVT           AREA                                   1.80
           BVT           SPAN                                  90.0     SQFT
           CBARVT        MEAN CHORD                            12.7     FT
           (T/C)VT       THICKNESS / CHORD                      7.1     FT
                                                                0.120

        PRIMARY ENG. NACELLE
           LN            LENGTH
           DBARN         MEAN DIAMETER                          0.0     FT
           SN            WETTED AREA                            0.0     FT
                                                                0.0     SQRT
        LIFT ENG. NACELLE
                         NO LIFT PROPULSION SELECTED

        PROPELLER
           D             DIAMETER
           SIGMA R/P     SOLIDITY                              11.5     FT
           WG/A          DISC LOADING                           0.204
           CT/SIGMA      THRUST COEFF. / SOLIDITY             130.1     LB/SQFT
           NR            NO. OF PROPELLERS                      0.0
           NO. BLADES    NO. OF BLADES/PROP                     2.000
                                                                4.000
```

V A S C O M P II
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W E I G H T S D A T A IN LBS

GLF	GUST LOAD FACTOR	4.136		
STRUCTURES GROUP				
K8 WW	WING	3223.		
K9 WHT	HOR. TAIL	355.		
K10 WVT	VERT. TAIL	255.		
K11 WB	FUSELAGE	1940.		
K12 WLG	LANDING GEAR	1351.		
K13 WLES	LIFT ENGINE SECTION	0.		
K14 WPES	PRIMARY ENGINE SECTION	537.		
DELTA WST	STRUCTURE WEIGHT INCREMENT	350.		
WST	TOTAL STRUCTURE WEIGHT	8011.		
PROPULSION GROUP				
K2 WR/P	ROTOR OR PROP	792.		
K3 WDS	DRIVE SYSTEM	1361.		
K4 WEL	LIFT ENGINES	0.		
K5 WEP	PRIMAPY ENGINES	976.		
K6 WLEI	LIFT ENGINE INSTALLATION	0.		
K7 WPEI	PRIMARY ENGINE INSTALLATION	293.		
K21 WFS	FUEL SYSTEM	1280.		
DELTA WP	PROPULSION GROUP WEIGHT INCREMENT	75.		
WP	TOTAL PROPULSION GROUP WEIGHT	4778.		
FLIGHT CONTROLS GROUP				
K15 WCC	COCKPIT CONTROLS	0.		
K16 WUC	UPPER CONTROLS	158.		
K17 WH	HYDRAULICS	0.		
K18 WFW	FIXED WING CONTROLS	649.		
K19 WSAS	SAS	0.		
K20 WTM	TILT MECHANISM	0.		
DELTA WFC	CONTROL WEIGHT INCREMENT	0.		
WFC	TOTAL CONTROL WEIGHT	807.		
WFE	WEIGHT OF FIXED EQUIPMENT	4000.		
WE	WEIGHT EMPTY	17596.		
WFUL	FIXED USEFUL LOAD	550.		
OWE	OPERATING WEIGHT EMPTY	18146.		
WPL	PAYLOAD	5000.		
(WF)A	FUEL	3879.	(WF)W	0.
WG	GROSS WEIGHT	27025.		

V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

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P R O P U L S I O N   D A T A
     PRIMARY PROPULSION CYCLE NO.     4.000
           TURBOSHAFT ENGINE

              2.   ENGINES

        BHPxP          MAX. STANDARD S.L. STATIC H.P.          10000.     H.P.

        ENGINE SIZE WAS FIXED BY INPUT

     NO LIFT ENGINE CYCLE SELECTED

     XMSN SIZED AT  90. PERCENT OF TOTAL PRIMARY ENGINE INSTALLED POWER
     (MAX.STANDARD S.L. STATIC H.P.),100.0 PERCENT HOVER RPM
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V A S C O M P II
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A E R O D Y N A M I C S D A T A

FE	TOTAL EFFECTIVE FLATPLATE AREA	12.417	SQFT
SWET	TOTAL WETTED AREA	1991.	SQFT
CBARF	MEAN SKIN FRICTION COEFF.	0.006237	

D R A G B R E A K D O W N IN SQFT

FEW	WING FE	0.0
FEF	FUSELAGE FE	7.013
FEVT	VERT. TAIL FE	0.0
FEHT	HOR. TAIL FE	0.0
FEN	PRIMARY ENG. NACELLE FE	0.0
FELN	LIFT ENG. NACELLE FE	0.0
DELTA FE	INCREMENTAL FE	5.405

A E R O D Y N A M I C C O E F F .

A1		0.71001	
A2		-0.09923	
A3		0.06623	
A4		0.11567	
A5		0.02297	
A6		1.29876	
A7		0.07318	
CL ALPHA	3-D LIFT SLOPE	4.97113	PER RADIAN
E	OSWALD FACTOR	0.79736	

V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

MISSION PERFORMANCE DATA

TAKEOFF, HOVER, OR LAND AT PETF = 1.000 LETF = 0.0 FOR 0.017 HRS.
VERTICAL RATE OF CLIMB = 0.' FT/MIN TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	LETF	THRUST TO WEIGHT	FM	BHP	CT	VTIP (FPS)
0.0	0.0	0.0	27025.	0.	0.0	2758.9	W	1.000	0.0	0.613	0.451	8834.	0.3210	900.
0.017	0.0	65.5	26959.	0.	0.0	2758.9	W	1.000	0.0	0.614	0.451	8834.	0.3210	900.

CLIMB TO OPT. ALT. FOR NEXT CRUISE WITH MAXIMUM R/C AT MILITARY ENGINE RATING, MAXIMUM ALT. 50000. FT.

TIME (HRS) / CL	RANGE (N.M.) / CD	FUEL USED (LBS) / L/D	WEIGHT (LBS.) / LIFT (LBS)	PRES. ALT. (FT) / DRAG (LBS)	TAS (KTS) / FUEL FLOW (LBS/HR)	TURB. TEMP. (R) / BHP	ENG. CODE	PLTF OR PEHF / THRUST (LBS)	EAS / CP	MACH / CT	MACH DIV / J	GAMMA (DEG) / VTIP (FPS)	THETA -F (DEG) / ETAP	R/C (FPM)
0.017	0.0	65.5	26959.	0.	206.8	2726.0	T	1.004	206.8	0.313	0.678	18.3	19.1	6589.
0.326	0.0308	10.608	25593.	2412.	3998.	8973.		10887.	0.3272	0.2110	1.219	900.0	0.786	
0.019	0.50	75.7	26949.	1000.	208.5	2726.0	T	0.977	205.4	0.316	0.677	17.2	18.1	6261.
0.333	0.0310	10.725	25738.	2400.	3908.	8823.		10626.	0.3314	0.2121	1.229	900.0	0.787	
0.022	1.03	86.1	26939.	2000.	213.2	2726.0	T	0.951	204.1	0.320	0.677	16.7	17.6	6106.
0.338	0.0313	10.805	25808.	2389.	3820.	8672.		10363.	0.3354	0.2131	1.239	900.0	0.787	
0.025	1.58	96.5	26928.	3000.	212.0	2726.0	T	0.927	202.8	0.324	0.676	16.1	17.1	5958.
0.343	0.0315	10.880	25873.	2378.	3733.	8518.		10100.	0.3395	0.2139	1.250	900.0	0.788	
0.027	2.15	106.9	26918.	4000.	213.7	2726.0	T	0.897	201.4	0.328	0.675	15.5	16.6	5826.
0.349	0.0318	10.956	25926.	2366.	3647.	8362.		9842.	0.3434	0.2148	1.260	900.0	0.788	
0.030	2.74	117.4	26907.	5000.	218.0	2726.0	T	0.878	202.4	0.335	0.674	14.2	15.2	5421.
0.348	0.0317	10.959	26085.	2380.	3567.	8219.		9525.	0.3478	0.2143	1.283	900.0	0.792	
0.033	3.39	128.3	26896.	6000.	221.2	2726.0	T	0.863	202.3	0.341	0.676	13.9	14.9	5386.
0.348	0.0318	10.959	26109.	2382.	3486.	8067.		9252.	0.3520	0.2145	1.304	900.0	0.795	
0.036	4.05	139.1	26886	7000.	222.1	2726.0	T	0.866	199.9	0.344	0.675	14.1	15.2	5491.
0.356	0.0322	11.042	26073.	2361.	3402.	7901.		9029.	0.3554	0.2159	1.309	900.0	0.795	
0.039	4.71	149.4	26875.	8000.	223.3	2726.0	T	0.868	198.0	0.347	0.674	13.6	14.8	5305.
0.364	0.0326	11.146	26126.	2344.	3319.	7735.		8798.	0.3589	0.2170	1.316	900.0	0.796	
0.043	5.39	159.9	26865.	9000.	224.2	2726.0	T	0.871	195.7	0.350	0.673	13.2	14.5	5197.
0.373	0.0331	11.252	26152.	2324.	3238.	7569.		8576.	0.3622	0.2182	1.322	900.0	0.796	
0.046	6.09	170.3	26855.	10000.	225.1	2726.0	T	0.874	193.4	0.352	0.672	12.8	14.2	5042.
0.382	0.0336	11.356	26190.	2306.	3158.	7401.		8353.	0.3655	0.2192	1.327	900.0	0.796	

0.049	6.82	180.7	26844.	11000.	226.0	2726.0	T	0.876	191.2	0.355	0.671	12.3	13.9	4895.
0.392	0.0342	11.455	26224.	2289.	3079.	7233.		8132.	0.3686	0.2203	1.332	900.0	0.796	
0.053	7.57	191.2	26834.	12000.	226.9	2726.0	T	0.878	188.9	0.358	0.670	11.9	13.5	4743.
0.401	0.0347	11.550	26257.	2273.	3002.	7065.		7911.	0.3717	0.2212	1.338	900.0	0.796	
0.056	8.35	201.7	26823.	13000.	227.9	2726.0	T	0.881	186.7	0.361	0.669	11.5	13.2	4593.
0.412	0.0354	11.640	26287.	2258.	2925.	6898.		7693.	0.3747	0.2221	1.343	900.0	0.796	
0.060	9.16	212.3	26812.	14000.	228.8	2726.0	T	0.883	184.4	0.364	0.668	11.0	12.9	4442.
0.422	0.0360	11.725	26316.	2244.	2850.	6730.		7476.	0.3776	0.2229	1.349	900.0	0.796	
0.063	10.00	223.0	26802.	15000.	229.7	2726.0	T	0.885	182.2	0.367	0.667	10.6	12.6	4285.
0.433	0.0367	11.804	26344.	2232.	2777.	6564.		7260.	0.3804	0.2236	1.354	900.0	0.796	
0.067	10.88	233.8	26791.	16000.	230.7	2726.0	T	0.887	180.0	0.370	0.666	10.2	12.3	4130.
0.444	0.0374	11.876	26370.	2220.	2704.	6398.		7046.	0.3832	0.2243	1.360	900.0	0.796	
0.071	11.80	244.8	26780.	17000.	231.7	2726.0	T	0.890	177.8	0.373	0.665	9.7	12.0	3972.
0.455	0.0381	11.941	26394.	2210.	2633.	6234.		6834.	0.3858	0.2248	1.366	900.0	0.796	
0.076	12.76	255.8	26769.	18000.	232.6	2726.0	T	0.892	175.6	0.376	0.664	9.3	11.7	3819.
0.467	0.0389	12.000	26416.	2201.	2564.	6070.		6625.	0.3884	0.2253	1.372	900.0	0.796	
0.080	13.76	267.0	26758.	19000.	233.4	2726.0	T	0.894	173.3	0.378	0.662	9.0	11.5	3682.
0.481	0.0399	12.054	26432.	2193.	2495.	5907.		6421.	0.3908	0.2258	1.376	900.0	0.795	
0.084	14.80	278.3	26747.	20000.	234.2	2726.0	T	0.896	170.9	0.381	0.661	8.5	11.2	3521.
0.494	0.0408	12.101	26450.	2186.	2427.	5745.		6219.	0.3932	0.2262	1.381	900.0	0.794	
0.089	15.90	289.8	26735.	21000.	235.0	2726.0	T	0.897	168.6	0.384	0.660	8.1	11.0	3363.
0.508	0.0418	12.138	26467.	2180.	2361.	5585.		6020.	0.3955	0.2266	1.385	900.0	0.794	
0.094	17.05	301.5	26723.	22000.	235.8	2726.0	T	0.899	166.4	0.387	0.658	7.7	10.7	3203.
0.522	0.0429	12.167	26482.	2177.	2296.	5427.		5823.	0.3977	0.2268	1.391	900.0	0.793	
0.099	18.27	313.4	26711.	23000.	236.7	2726.0	T	0.901	164.1	0.390	0.657	7.3	10.5	3046.
0.537	0.0440	12.186	26495.	2174.	2233.	5270.		5628.	0.3999	0.2270	1.396	900.0	0.792	
0.105	19.56	325.6	26699.	24000.	237.7	2726.0	T	0.903	161.9	0.393	0.655	6.9	10.2	2885.
0.552	0.0452	12.195	26507.	2174.	2170.	5116.		5435.	0.4019	0.2270	1.401	900.0	0.791	
0.111	20.92	338.2	26687.	25000.	238.8	2726.0	T	0.905	159.8	0.396	0.654	6.5	10.0	2721.
0.566	0.0464	12.196	26517.	2174.	2110.	4965.		5244.	0.4040	0.2268	1.408	900.0	0.790	

CRUISE AT BEST RANGE SPEED WITH HEADWIND OF 0.0 KNOTS TEMPERATURE = -30.1 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	SPEC. RANGE (NMPP)	ETAP PROP
CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW (LBS/HR)	BHP		THRUST (LBS)	CP	CT	J	VTIP (FPS)	
0.111	20.92	338.2	26687.	25000.	263.6	2033.6	P	0.455	176.5	0.438	0.664	.24309	0.855
0.468	0.0390	11.997	26687.	2224.	1076.	2150.		2225.	0.5101	0.1964	2.221	630.0	
0.183	40.00	416.0	26609.	25000.	263.6	2032.1	P	0.453	176.5	0.438	0.664	.24562	0.855
0.466	0.0389	11.991	26609.	2219.	1073.	2144.		2220.	0.5088	0.1960	2.221	630.0	

0.259 0.468	60.00 0.0390	497.5 12.001	26527. 26527.	25000. 2210.	262.6 1067.	2028.2 2128.	P	0.450 2211.	175.8 0.5048	0.436 0.1952	0.664 2.212	.24617 630.0	0.855
0.335 0.467	80.00 0.0389	578.7 11.994	26446. 26446.	25000. 2205.	262.6 1064.	2026.7 2122.	P	0.449 2206.	175.8 0.5034	0.436 0.1947	0.664 2.212	.24673 630.0	0.856
0.411 0.465	100.00 0.0388	659.8 11.987	26365. 26365.	25000. 2199.	262.6 1062.	2025.1 2116.	P	0.448 2200.	175.8 0.5020	0.436 0.1942	0.664 2.212	.24729 630.0	0.856
0.487 0.464	120.00 0.0387	740.6 11.981	26284. 26284.	25000. 2194.	262.6 1060.	2023.5 2110.	P	0.446 2195.	175.8 0.5007	0.436 0.1937	0.664 2.212	.24784 630.0	0.856
0.563 0.463	140.00 0.0386	821.3 11.974	26203. 26203.	25000. 2188.	262.6 1057.	2022.0 2105.	P	0.445 2189.	175.8 0.4993	0.436 0.1932	0.664 2.212	.24839 630.0	0.856
0.601 0.462	150.00 0.0386	861.6 11.970	26163. 26163.	25000. 2186.	262.6 1056.	2021.2 2102.	P	0.445 2187.	175.8 0.4986	0.436 0.1930	0.664 2.212	.24867 630.0	0.856

TRANSFER ALTITUDE TO 0. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
0.601	150.00	861.6	26163.	25000.
0.601	150.00	861.6	26163.	0.

CRUISE AT NORMAL ENGINE RATING TEMPERATURE = 59.0 DEG.F

TIME (HRS) CL	RANGE (N.M.) CD	FUEL USED (LBS) L/D	WEIGHT (LBS.) LIFT (LBS)	PRES. ALT. (FT) DRAG (LBS)	TAS (KTS) FUEL FLOW (LBS/HR)	TURB. TEMP. (R) BHP	ENG. CODE	PETF OR PEHF THRUST (LBS)	EAS CP	MACH CT	MACH DIV J	SPEC. RANGE (NMPP) VTIP (FPS)	ETAP PROP
0.601 0.097	150.00 0.0237	861.6 4.106	26163. 26163.	0. 6372.	383.3 3992.	2610.0 9248.	T	0.995 6357.	383.3 0.3373	0.579 0.1232	0.700 2.260	.09601 900.0	0.826
0.628 0.097	160.00 0.0237	965.7 4.090	26059. 26059.	0. 6371.	383.3 3992.	2610.0 9248.	T	0.995 6356.	383.3 0.3373	0.579 0.1232	0.700 2.260	.09602 900.0	0.826
0.680 0.096	180.00 0.0236	1174.0 4.058	25851. 25851.	0. 6370.	383.4 3993.	2610.0 9249.	T	0.995 6355.	383.4 0.3373	0.579 0.1232	0.700 2.260	.09603 900.0	0.826
0.732 0.095	200.00 0.0236	1382.3 4.026	25642. 25642.	0. 6369.	383.5 3993.	2610.0 9249.	T	0.995 6354.	383.5 0.3373	0.580 0.1232	0.701 2.261	.09604 900.0	0.825
0.784 0.094	220.00 0.0236	1590.6 3.994	25434. 25434.	0. 6368.	383.5 3993.	2610.0 9250.	T	0.995 6353.	383.5 0.3373	0.580 0.1231	0.701 2.261	.09605 900.0	0.825
0.836 0.094	240.00 0.0236	1798.8 3.962	25226. 25226.	0. 6367.	383.6 3993.	2610.0 9251.	T	0.995 6352	383.6 0.3374	0.580 0.1231	0.701 2.262	.09606 900.0	0.825
0.862 0.093	250.00 0.0236	1902.9 3.946	25122. 25122.	0. 6366.	383.6 3993.	2610.0 9251.	T	0.995 6352.	383.6 0.3374	0.580 0.1231	0.701 2.262	.09607 900.0	0.825

TAKEOFF, HOVER, OR LAND AT PETF = 0.714 LETF = 0.0 FOR 0.083 HRS.
VERTICAL RATE OF CLIMB = 0.0 FT/MIN TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	LETF	THRUST TO WEIGHT	FM	BHP	CT	VTIP (FPS)
0.862	250.00	1902.9	25122.	0.	0.0	2522.0	W	0.714	0.0	0.613	0.566	6307.	0.2985	900.
0.879	250.00	1954.4	25070.	0.	0.0	2522.0	W	0.714	0.0	0.614	0.566	6307.	0.2985	900.
0.896	250.00	2005.9	25019.	0.	0.0	2522.0	W	0.714	0.0	0.615	0.566	6307.	0.2985	900.
0.912	250.00	2057.4	24967.	0.	0.0	2522.0	W	0.714	0.0	0.617	0.566	6307.	0.2985	900.
0.929	250.00	2108.9	24916.	0.	0.0	2522.0	W	0.714	0.0	0.618	0.566	6307.	0.2985	900.
0.946	250.00	2160.3	24865.	0.	0.0	2522.0	W	0.714	0.0	0.619	0.566	6307.	0.2985	900.

RUISE AT NORMAL ENGINE RATING TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	SPEC. RANGE (NMPP)	ETAP PROP
CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW (LBS/HR)	BHP		THRUST (LBS)	CP	CT	J	VTIP (FPS)	
0.946	250.00	2160.3	24865.	0.	383.7	2610.0	T	0.995	383.7	0.580	0.701	.09608	0.825
0.092	0.0236	3.906	24865.	6365.	3993.	9252.		6350.	0.3374	0.1231	2.262	900.0	
0.972	260.00	2264.3	24760.	0.	383.7	2610.0	T	0.995	383.7	0.580	0.701	.09608	0.825
0.092	0.0236	3.890	24760.	6365.	3993.	9252.		6350.	0.3374	0.1231	2.262	900.0	
1.024	280.00	2472.5	24552.	0.	383.8	2610.0	T	0.995	383.8	0.580	0.701	.09609	0.825
0.091	0.0236	3.858	24552.	6364.	3994.	9252.		6349.	0.3374	0.1231	2.263	900.0	
1.076	300.00	2680.6	24344.	0.	383.8	2610.0	T	0.995	383.8	0.580	0.701	.09611	0.825
0.090	0.0236	3.826	24344.	6363.	3994.	9253.		6348.	0.3374	0.1230	2.263	900.0	
1.128	320.00	2888.7	24136.	0.	383.9	2610.0	T	0.995	383.9	0.580	0.701	.09612	0.825
0.089	0.0236	3.794	24136.	6362.	3994.	9253.		6347.	0.3375	0.1230	2.263	900.0	
1.180	340.00	3096.8	23928.	0.	383.9	2610.0	T	0.995	383.9	0.580	0.701	.09613	0.825
0.089	0.0235	3.762	23928.	6361.	3994.	9254.		6346.	0.3375	0.1230	2.264	900.0	
1.206	350.00	3200.8	23824.	0.	384.0	2610.0	T	0.995	384.0	0.580	0.701	.09613	0.825
0.088	0.0235	3.746	23824.	6360.	3994.	9254.		6345.	0.3375	0.1230	2.264	900.0	

LIMB TO OPT. ALT. FOR NEXT CRUISE WITH MAXIMUM R/C AT MILITARY ENGINE RATING, MAXIMUM ALT. 50000. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	GAMMA (DEG)	THETA -F (DEG)	R/C (FPM)
CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW (LBS/HR)	BHP		THRUST (LBS)	CP	CT	J	VTIP (FPS)	ETAP	
1.206	350.00	3200.8	23824.	0.	205.4	2726.0	T	1.003	205.4	0.310	0.682	21.4	21.7	7589.
0.287	0.0290	9.894	22184.	2242.	3995.	8964.		10928.	0.3269	0.2118	1.211	900.0	0.785	
1.208	350.42	3209.6	23815.	1000.	206.7	2726.0	T	0.976	203.7	0.313	0.681	20.3	20.7	7262.
0.294	0.0293	10.045	22338.	2224.	3905.	8813.		10675.	0.3310	0.2131	1.219	900.0	0.785	
1.211	350.87	3218.6	23806.	2000.	208.1	2726.0	T	0.950	202.0	0.317	0.680	19.7	20.1	7098.
0.300	0.0295	10.159	22417.	2207.	3817.	8659.		10421.	0.3350	0.2142	1.227	900.0	0.785	
1.213	351.33	3227.5	23797.	3000.	209.7	2726.0	T	0.926	200.6	0.320	0.680	18.9	19.5	6897.
0.305	0.0297	10.261	22509.	2194.	3729.	8505.		10159.	0.3389	0.2152	1.237	900.0	0.785	

1.215	351.81	3236.5	23788.	4000.	211.4	2726.0	T	0.896	199.3	0.324	0.679	18.3	18.9	6739.
0.310	0.0300	10.355	22581.	2181.	3643.	8349.		9899.	0.3428	0.2160	1.247	900.0	0.786	
1.218	352.30	3245.6	23779.	5000.	213.6	2726.0	T	0.876	198.2	0.328	0.679	17.6	18.2	6526.
0.315	0.0302	10.436	22672.	2172.	3559.	8193.		9631.	0.3468	0.2166	1.259	900.0	0.787	
1.220	352.82	3254.6	23770.	6000.	219.5	2726.0	T	0.863	200.7	0.339	0.680	15.5	16.0	5935.
0.310	0.0299	10.383	22909.	2206.	3483.	8058.		9287.	0.3516	0.2154	1.294	900.0	0.793	
1.223	353.42	3264.4	23760.	7000.	220.4	2726.0	T	0.866	198.4	0.341	0.679	16.6	17.2	6366.
0.316	0.0302	10.438	22775.	2182.	3399.	7892.		9064.	0.3550	0.2167	1.299	900.0	0.793	
1.226	353.97	3273.3	23751.	8000.	221.2	2726.0	T	0.868	196.1	0.344	0.678	16.1	16.8	6209.
0.324	0.0306	10.575	22822.	2158.	3316.	7725.		8841.	0.3584	0.2180	1.304	900.0	0.793	
1.229	354.54	3282.2	23743.	9000.	222.0	2726.0	T	0.871	193.7	0.346	0.677	15.6	16.4	6048.
0.332	0.0310	10.709	22868.	2135.	3234.	7557.		8619.	0.3617	0.2192	1.309	900.0	0.793	
1.231	355.13	3291.1	23734.	10000.	222.8	2726.0	T	0.873	191.4	0.349	0.676	15.1	16.0	5882.
0.341	0.0315	10.840	22914.	2114.	3154.	7389.		8397.	0.3649	0.2204	1.313	900.0	0.793	
1.234	355.74	3300.1	23725.	11000.	223.3	2726.0	T	0.876	188.9	0.351	0.675	14.7	15.8	5747.
0.351	0.0320	10.975	22947.	2091.	3075.	7219.		8181.	0.3679	0.2216	1.317	900.0	0.793	
1.237	356.37	3309.0	23716.	12000.	224.2	2726.0	T	0.878	186.7	0.354	0.674	14.1	15.3	5544.
0.360	0.0325	11.097	22999.	2072.	2997.	7051.		7961.	0.3710	0.2226	1.322	900.0	0.793	
1.240	357.02	3318.0	23707.	13000.	225.1	2726.0	T	0.881	184.4	0.356	0.673	13.6	14.9	5380.
0.370	0.0330	11.215	23038.	2054.	2921.	6883.		7742.	0.3739	0.2235	1.327	900.0	0.793	
1.243	357.70	3327.0	23698.	14000.	226.1	2726.0	T	0.883	182.3	0.359	0.672	13.1	14.5	5197.
0.379	0.0335	11.324	23080.	2038.	2846.	6717.		7522.	0.3768	0.2243	1.333	900.0	0.793	
1.246	358.41	3336.2	23689.	15000.	227.0	2726.0	T	0.885	180.0	0.362	0.671	12.7	14.1	5041.
0.389	0.0340	11.430	23113.	2022.	2772.	6550.		7306.	0.3796	0.2251	1.338	900.0	0.793	
1.250	359.14	3345.3	23679.	16000.	227.8	2726.0	T	0.887	177.8	0.365	0.670	12.2	13.8	4875.
0.400	0.0346	11.533	23146.	2007.	2700.	6384.		7093.	0.3823	0.2258	1.343	900.0	0.793	
1.253	359.90	3354.6	23670.	17000.	228.6	2726.0	T	0.890	175.5	0.368	0.669	11.7	13.5	4709.
0.411	0.0353	11.632	23176.	1992.	2628.	6219.		6882.	0.3849	0.2264	1.348	900.0	0.793	

CRUISE AT BEST RANGE SPEED WITH HEADWIND OF 0.0 KNOTS TEMPERATURE = -1.6 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	SPEC. RANGE (NMPP)	ETAP PROP
CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW (LBS/HR)	BHP		THRUST (LBS)	CP	CT	J	VTIP (FPS)	
1.253	359.90	3354.6	23670.	17000.	213.8	2203.2	P	0.522	164.1	0.344	0.662	.27125	0.860
0.480	0.0398	12.049	23670.	1964.	788.	1532.		1967.	0.2765	0.1321	1.800	630.0	
1.347	380.30	3428.7	23596.	17000.	213.8	2201.5	P	0.521	164.1	0.344	0.663	.27187	0.860
0.478	0.0397	12.043	23596.	1959.	786.	1528.		1962.	0.2757	0.1317	1.800	630.0	
1.441	400.00	3502.2	23522.	17000.	213.8	2199.7	P	0.519	164.1	0.344	0.663	.27248	0.860
0.477	0.0396	12.037	23522.	1954.	785.	1524.		1957.	0.2750	0.1314	1.800	630.0	

1.534	420.00	3575.6	23449.	17000.	212.8	2194.8	P	0.515	163.3	0.342	0.662	.27309	0.860
0.480	0.0398	12.049	23449.	1946.	779.	1511.		1949.	0.2726	0.1308	1.792	630.0	
1.628	440.00	3648.9	23376.	17000.	212.8	2193.0	P	0.514	163.3	0.342	0.663	.27370	0.860
0.478	0.0397	12.043	23376.	1941.	777.	1507.		1944.	0.2719	0.1305	1.792	630.0	
1.722	460.00	3721.9	23303.	17000.	212.8	2191.3	P	0.512	163.3	0.342	0.663	.27432	0.860
0.477	0.0396	12.037	23303.	1936.	776.	1503.		1939.	0.2712	0.1302	1.792	630.0	
1.816	480.00	3794.9	23230.	17000.	212.8	2189.6	P	0.511	163.3	0.342	0.663	.27493	0.860
0.475	0.0395	12.031	23230.	1931.	774.	1499.		1934.	0.2704	0.1298	1.792	630.0	
1.910	500.00	3867.6	23157.	17000.	212.8	2187.9	P	0.510	163.3	0.342	0.663	.27555	0.360
0.474	0.0394	12.025	23157.	1926.	772.	1495.		1928.	0.2697	0.1295	1.792	630.0	
1.910	500.00	3867.6	23157.	17000.	212.8	2187.9	P	0.510	163.3	0.342	0.663	.27555	0.860
0.474	0.0394	12.025	23157.	1926.	772.	1495.		1928.	0.2697	0.1295	1.792	630.0	

MISSION FUEL REQUIRED = 3867.60
RESERVE FUEL REQUIRED = 0.0
TOTAL FUEL REQUIRED = 3867.60

V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

MISSION PERFORMANCE DATA

TRANSFER ALTITUDE TO 1000. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
0.0	0.0	0.0	27025.	0.
0.0	0.0	0.0	27025.	1000.

CLIMB TO 1020. FT. WITH CONSTANT TAS AT MAXIMUM ENGINE RATING

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	GAMMA (DEG)	THETA -F (DEG)	R/C (FPM)
CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW (LBS/HR)	BHP		THRUST (LBS)	CP	CT	J	VTIP (FPS)	ETAP	
0.0	0.0	0.0	27025.	1000.	300.0	2691.9	W	1.000	295.6	0.455	0.660	3.5	2.4	1852.
0.168	0.0417	4.036	26975.	6683.	3993.	9199.		8329.	0.3455	0.1663	1.769	900.0	0.851	
0.000	0.05	0.7	27024.	1020.	300.0	2692.4	W	1.000	295.5	0.455	0.660	3.5	2.4	1854.
0.169	0.0418	4.037	26974.	6682.	3993.	9200.		8330.	0.3457	0.1664	1.769	900.0	0.851	

MISSION FUEL REQUIRED = 0.72
RESERVE FUEL REQUIRED = 0.0
TOTAL FUEL REQUIRED = 0.72

****

OF SUCCESSFUL CASE

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V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

THE FOLLOWING IS A CARD BY CARD REPRODUCTION OF THE INPUT DECK FOR THIS CASE

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LOC.  CORRESPONDS TO LOCATION NUMBER GIVEN ON INPUT SHEET
NUM   STANDS FOR THE NUMBER OF SEQUENTIAL INPUT VALUES STARTING WITH LOC. (MAX. =5)
VAL   EQUALS VALUE FOR VARIABLE CORRESPONDING TO LOC.
VAL1         VALUE              CORRESPONDING TO LOC.+0001
VAL2         VALUE              CORRESPONDING TO LOC.+0002
      ETC.
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LOC.	NUM	VAL	VAL1	VAL2	VAL3	VAL4
200	1	.0				
257	2	1.0000	.90000			
232	3	.93000	.93000	.93000		
245	1	2.0000				
235	2	.0	.80000			
246	2	.70000	.85000			
207	5	.0	.63100	.0	1.0000	.0
214	4	.0	225.00	.0	1.0000	

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WG = 0.200000E+05  WFA = 0.387924E+04  WFR = 0.718750E+00
WG = 0.200000E+05  WFA = 0.461210E+03  WFR = 0.342134E+04
WG = 0.242283E+05  WFA = 0.276318E+04  WFR = 0.371122E+04
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V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

S I Z E D A T A THIS RUN CONVERGED IN 3 ITERATIONS

GROSS WEIGHT = 26221. LB

FUSELAGE			
LF	LENGTH	46.0	FT
WF	WIDTH	4.3	FT
SF	WETTED AREA	530.	SQFT
WING			
AR	ASPECT RATIO	5.62	
SW	AREA	524.4	SQFT
B	SPAN	54.3	FT
CBARW	GEOM. MEAN CHORD	9.7	FT
LAMBDA C/4	QUARTER CHORD SWEEP	0.0	DEG
LAMBDA	TAPER RATIO	0.500	
(T/C)R	ROOT THICKNESS	0.170	
(T/C)T	TIP THICKNESS	0.130	
WG/SW	WING LOADING	50.0	LB/SQFT
C BAR / D	MEAN CHORD / PROP. DIA.	0.840	
HOR. TAIL			
ARHT	ASPECT RATIO	4.65	
SHT	AREA	128.0	SQFT
BHT	SPAN	24.4	FT
CBARHT	MEAN CHORD	5.2	FT
(T/C)HT	THICKNESS / CHORD	0.120	
VERT. TAIL			
ARVT	ASPECT RATIO	1.80	
SVT	AREA	90.0	SQFT
BVT	SPAN	12.7	FT
CBARVT	MEAN CHORD	7.1	FT
(T/C)VT	THICKNESS / CHORD	0.120	
PRIMARY ENG. NACELLE			
LN	LENGTH	0.0	FT
DBARN	MEAN DIAMETER	0.0	FT
SN	WETTED AREA	0.0	SQRT
LIFT ENG. NACELLE			
	NO LIFT PROPULSION SELECTED		
PROPELLER			
D	DIAMETER	11.5	FT
SIGMA R/P	SOLIDITY	0.204	
WG/A	DISC LOADING	126.2	LB/SQFT
CT/SIGMA	THRUST COEFF. / SOLIDITY	0.160	
NR	NO. OF PROPELLERS	2.000	
NO. BLADES	NO. OF BLADES/PROP	4.000	

V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

W E I G H T S D A T A IN LBS

GLF	GUST LOAD FACTOR	4.186		
STRUCTURES GROUP				
K8 WW	WING	3192.		
K9 WHT	HOR. TAIL	349.		
K10 WVT	VERT. TAIL	251.		
K11 WB	FUSELAGE	1938.		
K12 WLG	LANDING GEAR	1311.		
K13 WLES	LIFT ENGINE SECTION	0.		
K14 WPES	PRIMARY ENGINE SECTION	537.		
DELTA WST	STRUCTURE WEIGHT INCREMENT	350.		
WST	TOTAL STRUCTURE WEIGHT	7927.		
PROPULSION GROUP				
K2 WR/P	ROTOR OR PROP	792.		
K3 WDS	DRIVE SYSTEM	689.		
K4 WEL	LIFT ENGINES	0.		
K5 WEP	PRIMARY ENGINES	976.		
K6 WLEI	LIFT ENGINE INSTALLATION	0.		
K7 WPEI	PRIMARY ENGINE INSTALLATION	293.		
K21 WFS	FUEL SYSTEM	1273.		
DELTA WP	PROPULSION GROUP WEIGHT INCREMENT	75.		
WP	TOTAL PROPULSION GROUP WEIGHT	4099.		
FLIGHT CONTROLS GROUP				
K15 WCC	COCKPIT CONTROLS	0.		
K16 WUC	UPPER CONTROLS	158.		
K17 WH	HYDRAULICS	0.		
K18 WFW	FIXED WING CONTROLS	629.		
K19 WSAS	SAS	0.		
K20 WTM	TILT MECHANISM	0.		
DELTA WFC	CONTROL WEIGHT INCREMENT	0.		
WFC	TOTAL CONTROL WEIGHT	788.		
WFE	WEIGHT OF FIXED EQUIPMENT	4000.		
WE	WEIGHT EMPTY	16814.		
WFUL	FIXED USEFUL LOAD	550.		
OWE	OPERATING WEIGHT EMPTY	17364.		
WPL	PAYLOAD	5000.		
(WF)A	FUEL	3858.	(WF)W	0.
WG	GROSS WEIGHT	26221.		

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                       V A S C O M P  II
      V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93

 P R O P U L S I O N   D A T A
        PRIMARY PROPULSION CYCLE NO.     4.000
              TURBOSHAFT ENGINE

                 2.  ENGINES

           BHP*P        MAX. STANDARD S.L. STATIC H.P.         10000.     H.P.

           ENGINE SIZE WAS FIXED BY INPUT

        NO LIFT ENGINE CYCLE SELECTED

        XMSN SIZED AT  90. PERCENT OF ROTOR HOVER POWER REQUIRED
        AT H=    0. FT,TEMP= 59.00 DEG.F.,100.0  PERCENT HOVER RPM
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V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM   B-93

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A E R O D Y N A M I C S   D A T A
          FE         TOTAL EFFECTIVE FLATPLATE AREA          12.257     SQFT
          SWET       TOTAL WETTED AREA                        1961.     SQFT
          CBARF      MEAN SKIN FRICTION COEFF.  .          0.006252

D R A G   B R E A K D O W N       IN  SQFT
          FEW        WING FE                                  0.0
          FEF        FUSELAGE FE                              7.013
          FEVT       VERT. TAIL FE                            0.0
          FEHT       HOR.  TAIL FE                            0.0
          FEN        PRIMARY ENG. NACELLE FE                  0.0
          FELN       LIFT ENG. NACELLE FE                     0.0
          DELTA FE   INCREMENTAL FE                           5.244

A E R O D Y N A M I C   C O E F F .
          A1                                                0.70996
          A2                                               -0.09922
          A3                                                0.06625
          A4                                                0.11567
          A5                                                0.02337
          A6                                                1.30578
          A7                                                0.07127
          CL ALPHA   3-D LIFT SLOPE                         5.03255     PER RADIAN
          E          OSWALD   FACTOR                        0.79440
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V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM   B-93

MISSION PERFORMANCE DATA

TAKEOFF, HOVER, OR LAND AT PETF = 1.000 LETF = 0.0   FOR 0.017 HRS.
VERTICAL RATE OF CLIMB =   0.0 FT/MIN   TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	LETF	THRUST TO WEIGHT	FM	BHP	CT	VTIP (FPS)
0.0	0.0	0.0	26221.	0.	0.0	2758.9	W	1.000	0.0	1.023	0.930	8821.	0.5197	900.
0.017	0.0	65.5	26156.	0.	0.0	2758.9	W	1.000	0.0	1.025	0.930	8821.	0.5197	900.

CLIMB TO OPT. ALT. FOR NEXT CRUISE WITH   MAXIMUM R/C AT MILITARY ENGINE RATING, MAXIMUM ALT. 50000. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	GAMMA (DEG)	THETA -F (DEG)	R/C (FPM)
CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW (LBS/HR)	BHP		THRUST (LBS)	CP	CT	J	VTIP (FPS)	ETAP	
0.017	0.0	65.5	26156.	0.	148.2	2726.0	T	0.974	148.2	0.224	0.657	36.9	40.0	9018.
0.536	0.0439	12.204	20916.	1714.	3915.	8686.		17394.	0.3168	0.3371	0.874	900.0	0.930	
0.019	0.22	72.8	26148.	1000.	147.6	2726.0	T	0.948	145.4	0.224	0.654	36.6	40.0	8929.
0.558	0.0459	12.159	20979.	1725.	3825.	8528.		17148.	0.3203	0.3423	0.870	900.0	0.930	
0.020	0.44	79.9	26141.	2000.	146.4	2726.0	T	0.922	142.1	0.223	0.651	36.3	40.0	8788.
0.586	0.0484	12.125	21061.	1737.	3735.	8367.		16961.	0.3236	0.3487	0.863	900.0	0.930	
0.022	0.66	87.0	26134.	3000.	145.0	2726.0	T	0.894	138.7	0.221	0.648	36.0	40.0	8629.
0.618	0.0513	12.066	21154.	1753.	3645.	8202.		16788.	0.3269	0.3556	0.855	900.0	0.930	
0.024	0.89	94.0	26127.	4000.	143.4	2726.0	T	0.872	135.1	0.220	0.644	35.5	40.0	8448.
0.655	0.0547	11.978	21259.	1775.	3557.	8035.		16629.	0.3299	0.3629	0.845	900.0	0.930	
0.026	1.12	101.1	26120.	5000.	141.8	2726.0	T	0.859	131.6	0.218	0.640	35.1	40.0	8263.
0.694	0.0585	11.851	21370.	1803.	3469.	7867.		16465.	0.3329	0.3704	0.836	900.0	0.930	
0.028	1.36	108.1	26113.	6000.	140.0	2726.0	T	0.862	128.0	0.216	0.636	34.6	40.0	8056.
0.738	0.0631	11.690	21496.	1839.	3383.	7697.		16316.	0.3358	0.3783	0.825	900.0	0.930	
0.030	1.59	115.1	26106.	7000.	138.2	2726.0	T	0.865	124.4	0.214	0.631	34.1	40.0	7842.
0.786	0.0684	11.489	21630.	1883.	3297.	7526.		16161.	0.3385	0.3864	0.815	900.0	0.930	
0.032	1.84	122.1	26099.	8000.	136.4	2726.0	T	0.868	120.9	0.212	0.626	33.5	40.0	7622.
0.837	0.0744	11.250	21773.	1935.	3213.	7354.		16001.	0.3412	0.3946	0.804	900.0	0.930	
0.035	2.09	129.1	26092.	9000.	134.8	2726.0	T	0.871	117.7	0.210	0.621	32.9	40.0	7412.
0.890	0.0810	10.994	21917.	1994.	3130.	7183.		15814.	0.3438	0.4023	0.795	900.0	0.930	
0.037	2.34	136.1	26085.	10000.	133.0	2726.0	T	0.873	114.3	0.208	0.615	32.2	40.0	7177.
0.951	0.0889	10.691	22079.	2065.	3048.	7011.		15645.	0.3462	0.4106	0.784	900.0	0.930	

0.039	2.60	143.2	26078.	11000.	131.4	2726.0	T	0.876	111.2	0.207	0.609	31.5	40.0	6951.
1.013	0.0977	10.365	22243.	2146.	2967.	6840.		15449.	0.3486	0.4185	0.775	900.0	0.930	
0.042	2.87	150.3	26071.	12000.	129.8	2726.0	T	0.879	108.1	0.205	0.602	30.7	40.0	6717.
1.080	0.1078	10.018	22416.	2237.	2888.	6669.		15248.	0.3509	0.4264	0.765	900.0	0.930	
0.044	3.15	157.5	26064.	13000.	148.4	2726.0	T	0.881	121.6	0.235	0.621	19.8	27.4	5094.
0.933	0.0810	11.515	24523.	2130.	2824.	6560.		13119.	0.3564	0.3788	0.875	900.0	0.930	
0.047	3.61	166.7	26054.	14000.	155.7	2726.0	T	0.883	125.5	0.247	0.625	20.7	27.6	5565.
0.870	0.0758	11.488	24380.	2122.	2754.	6418.		12235.	0.3601	0.3648	0.918	900.0	0.930	
0.050	4.04	175.0	26046.	15000.	161.7	2726.0	T	0.886	128.3	0.258	0.628	19.4	25.9	5438.
0.840	0.0725	11.579	24570.	2122.	2685.	6273.		11513.	0.3636	0.3546	0.953	900.0	0.930	
0.053	4.51	183.2	26038.	16000.	167.0	2726.0	T	0.888	130.3	0.267	0.629	18.2	24.5	5283.
0.819	0.0704	11.640	24737.	2125.	2617.	6126.		10888.	0.3669	0.3466	0.984	900.0	0.930	
0.057	5.01	191.5	26030.	17000.	171.9	2726.0	T	0.890	131.9	0.276	0.631	17.0	23.2	5103.
0.804	0.0688	11.689	24887.	2129.	2550.	5979.		10324.	0.3701	0.3396	1.013	900.0	0.930	
0.060	5.55	199.8	26021.	18000.	176.5	2726.0	T	0.892	133.3	0.285	0.632	16.0	22.0	4916.
0.792	0.0676	11.727	25019.	2134.	2484.	5832.		9805.	0.3732	0.3335	1.041	900.0	0.930	
0.063	6.12	208.2	26013.	19000.	181.0	2726.0	T	0.894	134.4	0.293	0.633	14.9	20.8	4726.
0.783	0.0666	11.757	25135.	2138.	2419.	5686.		9322.	0.3762	0.3279	1.067	900.0	0.930	
0.067	6.74	216.7	26004.	20000.	185.4	2726.0	T	0.896	135.3	0.302	0.633	14.0	19.8	4535.
0.775	0.0658	11.780	25236.	2142.	2355.	5540.		8870.	0.3792	0.3227	1.093	900.0	0.930	
0.070	7.40	225.4	25996.	21000.	189.7	2726.0	T	0.898	136.1	0.310	0.634	13.1	18.8	4343.
0.769	0.0652	11.799	25324.	2146.	2293.	5396.		8444.	0.3821	0.3178	1.118	900.0	0.930	
0.074	8.11	234.2	25987.	22000.	193.9	2726.0	T	0.900	136.8	0.318	0.634	12.2	17.9	4151.
0.763	0.0646	11.815	25401.	2150.	2233.	5253.		8040.	0.3850	0.3132	1.143	900.0	0.930	
0.078	8.87	243.2	25978.	23000.	198.1	2726.0	T	0.902	137.4	0.326	0.635	11.4	17.0	3962.
0.759	0.0642	11.826	25467.	2153.	2174.	5112.		7658.	0.3878	0.3088	1.168	900.0	0.930	
0.082	9.69	252.3	25969.	24000.	202.4	2726.0	T	0.904	137.9	0.335	0.635	10.6	16.2	3768.
0.755	0.0638	11.838	25527.	2156.	2116.	4972.		7292.	0.3907	0.3045	1.193	900.0	0.930	
0.087	10.57	261.7	25960.	25000.	205.8	2726.0	T	0.905	137.8	0.342	0.635	10.0	15.7	3634.
0.758	0.0641	11.817	25562.	2163.	2058.	4832.		6968.	0.3932	0.3014	1.213	900.0	0.930	
0.091	11.50	271.1	25950.	26000.	210.5	2726.0	T	0.907	138.4	0.351	0.635	9.1	14.7	3371.
0.752	0.0635	11.840	25624.	2164.	2004.	4697.		6624.	0.3961	0.2968	1.241	900.0	0.930	
0.096	12.53	281.0	25940.	27000.	215.3	2726.0	T	0.909	139.1	0.360	0.636	8.4	13.9	3184.
0.746	0.0629	11.861	25662.	2164.	1951.	4565.		6295.	0.3990	0.2924	1.269	900.0	0.930	
0.102	13.65	291.2	25930.	28000.	219.6	2726.0	T	0.910	139.3	0.369	0.636	7.8	13.3	3031.
0.745	0.0628	11.863	25688.	2165.	1899.	4434.		5994.	0.4017	0.2886	1.294	900.0	0.930	
0.107	14.84	301.7	25920.	29000.	223.9	2726.0	T	0.912	139.5	0.378	0.636	7.2	12.7	2851.
0.743	0.0626	11.866	25714.	2167.	1848.	4305.		5706.	0.4045	0.2849	1.320	900.0	0.930	
0.113	16.14	312.5	25909.	30000.	228.3	2726.0	T	0.913	139.7	0.387	0.636	6.6	12.1	2674.
0.742	0.0625	11.869	25735.	2168.	1799.	4178.		5430.	0.4072	0.2813	1.346	900.0	0.930	

0.119	17.56	323.7	25897.	31000.	232.7	2726.0	T	0.915	139.7	0.396	0.636	6.1	11.6	2508.
0.742	0.0625	11.865	25751.	2170.	1750.	4053.		5170.	0.4099	0.2779	1.372	900.0	0.930	

CRUISE AT BEST RANGE SPEED WITH HEADWIND OF 0.0 KNOTS TEMPERATURE = -51.5 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	SPEC. RANGE (NMPP)	ETAP PROP
CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW (LBS/HR)	DHF		THRUST (LBS)	CP	CT	J	VTIP (FPS)	
0.119	17.56	323.7	25897.	31000.	280.5	2168.4	P	0.606	168.4	0.478	0.659	.25512	0.790
0.513	0.0422	12.178	25897.	2126.	1100.	2366.		2125.	0.6977	0.2332	2.363	630.0	
0.128	20.00	333.3	25888.	31000.	280.5	2168.1	P	0.606	168.4	0.478	0.659	.25520	0.790
0.513	0.0421	12.178	25888.	2126.	1099.	2365.		2125.	0.6975	0.2331	2.363	630.0	
0.199	40.00	411.6	25810.	31000.	280.5	2165.9	P	0.604	168.4	0.478	0.659	.25585	0.790
0.512	0.0420	12.174	25810.	2120.	1096.	2359.		2119.	0.6956	0.2325	2.363	630.0	
0.271	60.00	489.8	25731.	31000.	280.5	2163.6	P	0.603	168.4	0.478	0.659	.25649	0.790
0.510	0.0419	12.170	25731.	2114.	1094.	2353.		2113.	0.6937	0.2319	2.363	630.0	
0.342	80.00	567.8	25653.	31000.	279.5	2158.8	P	0.599	167.8	0.476	0.659	.25713	0.789
0.512	0.0421	12.175	25653.	2107.	1087.	2337.		2106.	0.6891	0.2310	2.354	630.0	
0.413	100.00	645.6	25576.	31000.	280.5	2159.2	P	0.599	168.4	0.478	0.660	.25778	0.790
0.507	0.0417	12.161	25576.	2103.	1088.	2340.		2102.	0.6900	0.2306	2.363	630.0	
0.485	120.00	723.1	25498.	31000.	280.5	2157.0	P	0.598	168.4	0.478	0.660	.25841	0.790
0.506	0.0416	12.156	25498.	2097.	1086.	2334.		2096.	0.6882	0.2300	2.363	630.0	
0.556	140.00	800.5	25421.	31000.	279.5	2152.2	P	0.594	167.8	0.476	0.660	.25905	0.789
0.508	0.0417	12.163	25421.	2090.	1079.	2318.		2089.	0.6836	0.2292	2.354	630.0	
0.592	150.00	839.1	25382.	31000.	279.5	2151.1	P	0.594	167.8	0.476	0.660	.25937	0.789
0.507	0.0417	12.160	25382.	2087.	1078.	2315.		2086.	0.6827	0.2289	2.354	630.0	

TRANSFER ALTITUDE TO 0. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
0.592	150.00	839.1	25382.	31000.
0.592	150.00	839.1	25382.	0.

CRUISE AT NORMAL ENGINE RATING TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	SPEC. RANGE (NMPP)	ETAP PROP
CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW (LBS/HR)	BHP		THRUST (LBS)	CP	CT	J	VTIP (FPS)	
0.592	150.00	839.1	25382.	0.	382.0	2610.0	T	0.994	382.0	0.577	0.700	.09577	0.808
0.098	0.0241	4.067	25382.	6241.	3989.	9236.		6236.	0.3368	0.1209	2.252	900.0	
0.618	160.00	943.6	25278.	0.	382.0	2610.0	T	0.994	382.0	0.577	0.700	.09578	0.808

0.097	0.0240	4.050	25278.	6241.	3989.	9236.		6236.	0.3368	0.1209	2.252	900.0	
0.670	180.00	1152.4	25069.	0.	382.1	2610.0	T	0.994	382.1	0.577	0.700	.09579	0.808
0.097	0.0240	4.017	25069.	6240.	3989.	9237.		6235.	0.3369	0.1209	2.253	900.0	
0.723	200.00	1361.2	24860.	0.	382.2	2610.0	T	0.994	382.2	0.578	0.700	.09580	0.808
0.096	0.0240	3.984	24860.	6239.	3989.	9238.		6235.	0.3369	0.1208	2.253	900.0	
0.775	220.00	1569.9	24651.	0.	382.3	2610.0	T	0.994	382.3	0.578	0.701	.09582	0.808
0.095	0.0240	3.951	24651.	6239.	3990.	9238.		6234.	0.3369	0.1208	2.254	900.0	
0.827	240.00	1778.7	24442.	0.	382.3	2610.0	T	0.994	382.3	0.578	0.701	.09583	0.808
0.094	0.0240	3.918	24442.	6238.	3990.	9239.		6234.	0.3369	0.1208	2.254	900.0	
0.853	250.00	1883.0	24338.	0.	382.4	2610.0	T	0.994	382.4	0.578	0.701	.09584	0.808
0.094	0.0240	3.902	24338.	6238.	3990.	9239.		6233.	0.3369	0.1208	2.254	900.0	

TAKEOFF, HOVER, OR LAND AT PETF = 0.714 LETF = 0.0 FOR 0.083 HRS.
VERTICAL RATE OF CLIMB = 0.0 FT/MIN TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	LETF	THRUST TO WEIGHT	FM	BHP	CT	VTIP (FPS)
0.853	250.00	1883.0	24338.	0.	0.0	2522.0	W	0.714	0.0	0.880	0.930	6299.	0.4152	900.
0.870	250.00	1934.5	24287.	0.	0.0	2522.0	W	0.714	0.0	0.882	0.930	6299.	0.4152	900.
0.887	250.00	1986.0	24235.	0.	0.0	2522.0	W	0.714	0.0	0.884	0.930	6299.	0.4152	900.
0.903	250.00	2037.5	24184.	0.	0.0	2522.0	W	0.714	0.0	0.886	0.930	6299.	0.4152	900.
0.920	250.00	2089.0	24132.	0.	0.0	2522.0	W	0.714	0.0	0.888	0.930	6299.	0.4152	900.
0.937	250.00	2140.4	24081.	0.	0.0	2522.0	W	0.714	0.0	0.890	0.930	6299.	0.4152	900.

CRUISE AT NORMAL ENGINE RATING TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	SPEC. RANGE (NMPP)	ETAP PROP
CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW (LBS/HR)	BHP		THRUST (LBS)	CP	CT	J	VTIP (FPS)	
0.937	250.00	2140.4	24081.	0.	382.5	2610.0	T	0.994	382.5	0.578	0.701	.09585	0.808
0.093	0.0240	3.861	24081.	6237.	3990.	9240.		6233.	0.3370	0.1208	2.255	900.0	
0.963	260.00	2244.7	23976.	0.	382.5	2610.0	T	0.994	382.5	0.578	0.701	.09586	0.808
0.092	0.0240	3.844	23976.	6237.	3990.	9240.		6232.	0.3370	0.1208	2.255	900.0	
1.015	280.00	2453.3	23768.	0.	382.6	2610.0	T	0.994	382.6	0.578	0.701	.09587	0.808
0.091	0.0240	3.811	23768.	6236.	3990.	9241.		6232.	0.3370	0.1208	2.256	900.0	
1.067	300.00	2661.9	23559.	0.	382.6	2610.0	T	0.994	382.6	0.578	0.701	.09589	0.808
0.091	0.0240	3.778	23559.	6236.	3991.	9242.		6231.	0.3370	0.1208	2.256	900.0	
1.120	320.00	2870.5	23351.	0.	382.7	2610.0	T	0.994	382.7	0.578	0.701	.09590	0.808
0.090	0.0239	3.745	23351.	6235.	3991.	9242.		6231.	0.3371	0.1208	2.256	900.0	
1.172	340.00	3079.1	23142.	0.	382.8	2610.0	T	0.994	382.8	0.578	0.701	.09591	0.808
0.089	0.0239	3.712	23142.	6235.	3991.	9243.		6230.	0.3371	0.1208	2.257	900.0	
1.198	350.00	3183.4	23038.	0.	382.8	2610.0	T	0.995	382.8	0.579	0.701	.09592	0.808
0.088	0.0239	3.695	23038.	6234.	3991.	9243.		6230.	0.3371	0.1208	2.257	900.0	

CLIMB TO OPT. ALT. FOR NEXT CRUISE WITH MAXIMUM R/C AT MILITARY ENGINE RATING, MAXIMUM ALT. 50000. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	GAMMA (DEG)	THETA -F (DEG)	R/C (FPM)
CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW (LBS/HR)	BHP		THRUST (LBS)	CP	CT	J	VTIP (FPS)	ETAP	
1.198	350.00	3183.4	23038.	0.	162.6	2726.0	T	0.981	162.6	0.246	0.672	38.6	40.0	10289.
0.383	0.0338	11.312	17995.	1591.	3932.	8745.		15962.	0.3189	0.3094	0.959	900.0	0.930	
1.200	350.21	3189.7	23031.	1000.	162.0	2726.0	T	0.954	159.6	0.246	0.670	38.5	40.0	10212.
0.398	0.0348	11.422	18034.	1579.	3841.	8587.		15731.	0.3225	0.3140	0.955	900.0	0.930	
1.201	350.41	3196.0	23025.	2000.	160.8	2726.0	T	0.928	156.1	0.245	0.668	38.2	40.0	10087.
0.417	0.0361	11.564	18083.	1564.	3750.	8424.		15548.	0.3258	0.3196	0.948	900.0	0.930	
1.203	350.62	3202.2	23019.	3000.	159.2	2726.0	T	0.903	152.3	0.243	0.666	38.0	40.0	9929.
0.440	0.0376	11.712	18143.	1549.	3660.	8257.		15393.	0.3290	0.3260	0.939	900.0	0.930	
1.205	350.83	3208.3	23013.	4000.	157.4	2726.0	T	0.875	148.3	0.241	0.663	37.7	40.0	9753.
0.465	0.0393	11.845	18210.	1537.	3570.	8088.		15250.	0.3321	0.3328	0.928	900.0	0.930	
1.206	351.05	3214.4	23007.	5000.	155.6	2726.0	T	0.859	144.4	0.239	0.660	37.4	40.0	9573.
0.493	0.0413	11.941	18281.	1531.	3482.	7917.		15101.	0.3351	0.3397	0.917	900.0	0.930	
1.208	351.26	3220.5	23001.	6000.	153.6	2726.0	T	0.862	140.4	0.237	0.657	37.0	40.0	9376.
0.524	0.0436	12.009	18360.	1529.	3395.	7745.		14965.	0.3379	0.3470	0.906	900.0	0.930	
1.210	351.48	3226.5	22995.	7000.	151.4	2726.0	T	0.865	136.3	0.235	0.654	36.6	40.0	9157.
0.558	0.0464	12.045	18451.	1532.	3309.	7571.		14842.	0.3406	0.3549	0.893	900.0	0.930	
1.212	351.70	3232.5	22989.	8000.	149.2	2726.0	T	0.868	132.3	0.232	0.650	36.2	40.0	8932.
0.596	0.0496	12.032	18548.	1542.	3224.	7397.		14714.	0.3432	0.3628	0.880	900.0	0.930	
1.214	351.92	3238.6	22983.	9000.	147.0	2726.0	T	0.871	128.3	0.229	0.646	35.7	40.0	8702.
0.637	0.0532	11.967	18653.	1559.	3140.	7223.		14582.	0.3457	0.3709	0.867	900.0	0.930	
1.215	352.15	3244.6	22977.	10000.	144.8	2726.0	T	0.873	124.4	0.227	0.641	35.2	40.0	8466.
0.682	0.0575	11.851	18766.	1583.	3057.	7048.		14447.	0.3481	0.3792	0.854	900.0	0.930	
1.217	352.39	3250.6	22971.	11000.	142.6	2726.0	T	0.876	120.6	0.224	0.636	34.7	40.0	8224.
0.730	0.0625	11.685	18888.	1616.	2975.	6874.		14307.	0.3504	0.3875	0.841	900.0	0.930	
1.219	352.62	3256.6	22964.	12000.	140.4	2726.0	T	0.879	116.9	0.222	0.631	34.1	40.0	7974.
0.783	0.0683	11.469	19019.	1658.	2895.	6701.		14164.	0.3525	0.3961	0.828	900.0	0.930	
1.222	352.87	3262.7	22958.	13000.	138.4	2726.0	T	0.881	113.4	0.219	0.626	33.5	40.0	7733.
0.838	0.0747	11.207	19154.	1709.	2816.	6528.		13999.	0.3546	0.4042	0.816	900.0	0.930	
1.224	353.12	3268.7	22952.	14000.	136.2	2726.0	T	0.884	109.8	0.217	0.620	32.7	40.0	7466.
0.900	0.0824	10.924	19305.	1767.	2738.	6356.		13850.	0.3566	0.4130	0.803	900.0	0.930	
1.226	353.37	3274.9	22946.	15000.	134.2	2726.0	T	0.886	106.5	0.214	0.613	32.0	40.0	7207.
0.966	0.0912	10.590	19459.	1838.	2662.	6185.		13679.	0.3585	0.4214	0.791	900.0	0.930	
1.228	353.63	3281.0	22940.	16000.	132.2	2726.0	T	0.888	103.2	0.212	0.606	31.2	40.0	6938.
1.037	0.1014	10.227	19624.	1919.	2586.	6016.		13506.	0.3603	0.4299	0.779	900.0	0.930	

1.231	353.91	3287.2	22934.	17000.	149.7	2726.0	T	0.890	114.9	0.241	0.622	20.4	27.8	5290.
0.916	0.0789	11.608	21494.	1852.	2528.	5904.		11706.	0.3654	0.3851	0.883	900.0	0.930	
1.234	354.35	3295.2	22926.	18000.	157.6	2726.0	T	0.892	119.0	0.254	0.627	20.7	27.4	5652.
0.852	0.0734	11.610	21443.	1847.	2463.	5767.		10858.	0.3690	0.3693	0.929	900.0	0.930	
1.237	354.78	3302.5	22919.	19000.	163.9	2726.0	T	0.895	121.7	0.266	0.629	19.5	25.8	5536.
0.821	0.0702	11.684	21609.	1849.	2400.	5626.		10186.	0.3723	0.3582	0.966	900.0	0.930	
1.240	355.25	3309.7	22911.	20000.	169.5	2726.0	T	0.897	123.7	0.276	0.631	18.2	24.3	5363.
0.800	0.0681	11.741	21766.	1854.	2337.	5484.		9604.	0.3754	0.3494	0.999	900.0	0.930	
1.243	355.75	3316.9	22904.	21000.	174.6	2726.0	T	0.899	125.3	0.285	0.633	17.0	22.9	5169.
0.785	0.0666	11.784	21905.	1859.	2275.	5342.		9081.	0.3783	0.3418	1.029	900.0	0.930	
1.246	356.29	3324.3	22897.	22000.	179.5	2726.0	T	0.900	126.6	0.294	0.634	15.9	21.7	4963.
0.773	0.0654	11.817	22026.	1864.	2215.	5201.		8602.	0.3812	0.3351	1.058	900.0	0.930	

CRUISE AT BEST RANGE SPEED WITH HEADWIND OF 0.0 KNOTS TEMPERATURE = -19.5 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	SPEC. RANGE (NMPP)	ETAP PROP
CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW (LBS/HR)	BHP		THRUST (LBS)	CP	CT	J	VTIP (FPS)	
1.246	356.29	3324.3	22897.	22000.	224.6	2350.7	P	0.680	158.4	0.368	0.659	.27355	0.769
0.513	0.0421	12.177	22897.	1880.	821	1720.		1879.	0.3675	0.1494	1.892	630.0	
1.263	360.00	3337.8	22883.	22000.	224.6	2350.2	P	0.679	158.4	0.368	0.659	.27368	0.769
0.513	0.0421	12.177	22883.	1879.	821.	1719.		1878.	0.3673	0.1493	1.892	630.0	
1.352	380.00	3410.9	22810.	22000.	224.6	2347.6	P	0.677	158.4	0.368	0.659	.27438	0.769
0.511	0.0420	12.172	22810.	1874.	819.	1714.		1873.	0.3662	0.1489	1.892	630.0	
1.441	400.00	3483.8	22737.	22000.	224.6	2345.0	P	0.675	158.4	0.368	0.659	.27508	0.769
0.509	0.0419	12.168	22737.	1869.	817.	1709.		1868.	0.3652	0.1485	1.892	630.0	
1.530	420.00	3556.5	22665.	22000.	224.6	2342.5	P	0.674	158.4	0.368	0.660	.27578	0.769
0.508	0.0417	12.163	22665.	1863.	814.	1704.		1862.	0.3642	0.1481	1.892	630.0	
1.619	440.00	3629.0	22592.	22000.	224.6	2340.0	P	0.672	158.4	0.368	0.660	.27646	0.769
0.506	0.0416	12.158	22592.	1858.	812.	1700.		1857.	0.3632	0.1476	1.892	630.0	
1.708	460.00	3701.4	22520.	22000.	224.6	2337.5	P	0.670	158.4	0.368	0.660	.27715	0.769
0.505	0.0415	12.154	22520.	1853.	810.	1695.		1852.	0.3621	0.1472	1.892	630.0	
1.797	480.00	3773.5	22448.	22000.	224.6	2335.0	P	0.668	158.4	0.368	0.660	.27784	0.769
0.503	0.0414	12.149	22448.	1848.	808.	1690.		1847.	0.3611	[illegible]	1.892	630.0	
1.886	500.00	3845.5	22376.	22000.	224.6	2332.5	P	0.666	158.4	0.368	0.660	.27852	0.769
0.501	0.0413	12.144	22376.	1843.	806.	1685.		1842.	0.3601	0.1464	1.892	630.0	
1.886	500.00	3845.5	22376.	22000.	224.6	2332.5	P	0.666	158.4	0.368	0.660	.27852	0.769
0.501	0.0413	12.144	22376.	1843.	806.	1685.		1842.	0.3601	0.1464	1.892	630.0	

MISSION FUEL REQUIRED = 3845.53

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RESERVE FUEL REQUIRED =     0.0
TOTAL   FUEL REQUIRED =  3845.53
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V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM   B-93

MISSION PERFORMANCE DATA

TRANSFER ALTITUDE TO   1000. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
0.0	0.0	0.0	26221.	0.
0.0	0.0	0.0	26221.	1000.

CLIMB TO 1020. FT. WITH CONSTANT TAS AT MAXIMUM ENGINE RATING

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	GAMMA (DEG)	THETA -F (DEG)	R/C (FPM)
CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW (LBS/HR)	BHP		THRUST (LBS)	CP	CT	J	VTIP (FPS)	ETAP	
0.0	0.0	0.0	26221.	1000.	300.0	2691.9	W	1.000	295.6	0.455	0.660	5.8	4.7	3050.
0.168	0.0416	4.032	26089.	6470.	3993.	9199.		9100.	0.3455	0.1816	1.769	900.0	0.930	
0.000	0.03	0.4	26221.	1020.	300.0	2692.4	W	1.000	295.5	0.455	0.660	5.8	4.7	3052.
0.168	0.0417	4.033	26088.	6469.	3993.	9200.		9102.	0.3457	0.1818	1.769	900.0	0.930	

MISSION FUEL REQUIRED =   0.44
RESERVE FUEL REQUIRED =   0.0
TOTAL   FUEL REQUIRED =   0.44

****

END OF SUCCESSFUL CASE

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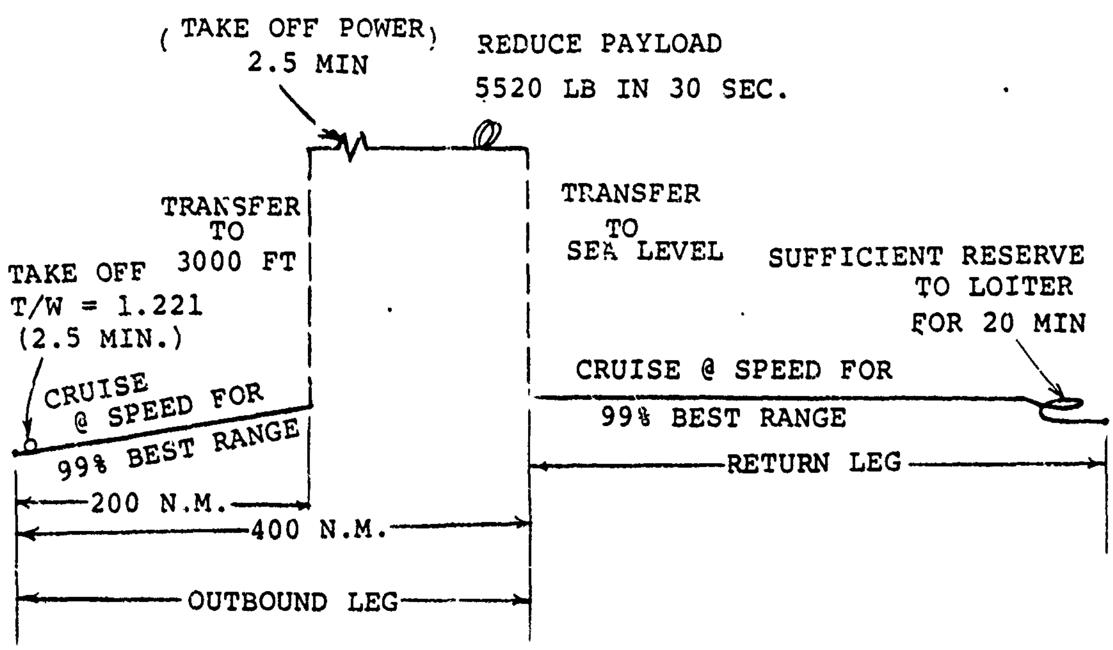
7.3.3 Tilt-Rotor Study Aircraft

Only those inputs which are of prime interest are discussed below. This sample case illustrates the use of the General Performance option (SGTIND=11.), and the Figure of Merit map. A copy of the output follows the input.



VASCOMP II - DESCRIPTION OF SAMPLE CASE 3

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS	
General Information Sheet				
OPTIND	0001	1.0	Sizing run	
TNIRPK	0002	1.0	Print indicator-optional print	
DRGIND	0003	0.0	Program calculates compressibility drag	
OSWIND	0004	1.0	Program calculates induced drag factor	
FDMIND	0006	0.0	Size fuselage for passenger requirements	
WDMIND	0007	0.0	Wing not dependent on propeller size	
HTIND	0008	1.0	Input tail volume coefficients	
VTIND	0009	1.0		
FIXIND	0010	1.0	Program sizes engines	
ENGIND	0011	0.0	Turboshaft primary engines	
LFTIND	0013	0.0	No lift engines specified	
WG_o	0014	35000.	1st guess at design gross weight	
h_o	0015	0.0	Start altitude	Normally 0. except for partial mission analysis
R_o	0016	0.0	Starting range	
t_o	0017	0.0	Starting time	
HOPTIN	0018	0.0	Cruise desired at specified altitude	
VLMIND	0019	0.0	Airspeed limited to 250 knots EAS at altitude of 10,000 ft or less	
M_{mo}	0020	0.681	Maximum operating mach number	
V_{mo}	0021	450.	Maximum operating EAS knots	
V_{DIVE}	0022	450.	Design dive speed	

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS	
M_{LF}	0023	3.0	Maneuver load factor	
K_1	0024	1.0	Factor on mission fuel burned to give reserve fuel, i.e. 1.1 would give 10% reserve	
SW_F	0025	0.	Fixed fuel increment for reserves or other use	
K_{FF}	0026	1.068	Use nominal engine fuel	
SGTIND	0027	2.	TAKEOFF	
	0028	4.	CRUISE	
	0029	9.	TRANSFER ALTITUDE	
	0030	2.	TAKEOFF	
	0031	8.	CHANGE PAYLOAD	
	0032	9.	TRANSFER ALTITUDE	
	0033	4.	CRUISE	SEQUENCE
	0034	6.	LOITER	OR
	0035	0.	END OF MISSION	DESIGN
	0036	4.	CRUISE	MISSION
	0037	0.	END OF MISSION	
	0038	9.	TRANSFER ALTITUDE	
	0039	4.	CRUISE	
	0040	0.	END OF MISSION	
	0041	11.	GENERAL PERFORMANCE	
	0042	100.	END OF CASE	

Aircraft Dimensional Sheet

AR	0101	6.0	Wing aspect ratio
1_W	0103	0.0	Wing incidence angle to fuselage horizontal datum (degrees)
$(L/_C)_R$	0104	.18	Root thickness-chord ratio
$(L/_C)_T$	0105	.18	Tip thickness-chord ratio
$W_G/_S$	0106	100.	Wing loading at design gross weight
$\Lambda c/4$	0107	0.	Quarter chord mean sweep angle, degrees
λ	0108	1.0	Taper ratio (tip chord/root chord)
AR_{HT}	0109	4.0	Horizontal tail aspect ratio

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
a_H	0110	.15	Vertical position of horizontal tail on vertical tail, spans above vertical tail root chord. Valve is 0. on or below root chord, 1.0 for "T" tail
l_{TH}	0111	22.67	Horizontal tail arm, FT
(t/c)HT	0112	.15	Horizontal tail mean thickness/ chord ratio
$\bar{V}_H$	0113	1.05	Horizontal tail volume coefficient
λ_H	0114	.4	Horizontal tail taper ratio
Γ	0116	.1	Prop blade attachment distance from centerline of hob (fraction of prop radius)
Y_{CL}	0117	9.1666	Clearance from inboard prop tip to inboard prop tip across fuselage (feet)
ζ_1	0118	0.	Prop over prop overlap (fraction of radius)
ζ_2	0119	1.0	Prop over wing tip overlap (fraction of radius)
$\Delta S_{WET}/S_W$	0120	0.	Increment in wetted are a for landing gear or other protusions
l_f	0122	46.5	Fuselage length (feet)
l_{RW}	0126	15.	Length of ramp well or other strengthened fuselage portion (e.g., rear engine attachments). Used to compute fuselage weight penalty.
S_F	0127	999.4	Fuselage wetted area (square feet)
ω_F	0128	7.1666	Width of fuselage (feet)
AR_{VT}	0129	1.153	Vertical tail aspect ratio
l_{TV}	0130	20.	Vertical tail arm
(t/c)VT	0131	.15	Vertical tail thickness/chord ratio

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
$\bar{V}_V$	0132	.128	Vertical tail volume coefficient
λ_V	0133	.325	Vertical tail taper ratio
Y_{mg}	0135	0.	Spanwise distance of landing gear from mean spanwise distance
Y_p	0136	.904	of cruise engine from wing root in semispans. Used in wing relief term.
Z_1	0139	0.0	} Primary engine nacelle constants
Z_2	0140	0.0	

Aircraft Propulsion Information Required When Using Turboshaft Engines - Primary Engine

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
η_pIND	0200	0.0	Program calculates prop performance
Cycle No.	0201	1.82	Cruise engine selection
SHP_p^*	0202	10000.	Maximum static sea level horsepower
N_p	0204	4	Number of cruise engines
η_T	0206	.97	Transmission efficiency
h_{TO}	0207	0.	Takeoff pressure altitude for engine sizing
n	0208	1.1955	Thrust to weight for engine sizing - takeoff condition
ΔTin_{TO}	0209	30.8	Increase in temperature above standard for engine sizing
N_{II}/N_{IIMAX}	0210	.943	Power turbine operating speed for engine sizing
N_{PO}	0211	0.0	Number of primary engines shut down during engine sizing
N_{LO}	0212	0.0	Number of lift engines shut down during engine sizing
N_R	0223	2.	Number of rotors

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
V_{TIP}	0224	775.18	Prop tip speed
$W_{G/A}$	0225	15.0	Disc loading
DIA	0226	35.0	Prop diameter
AF	0228	95.02	Activity factor per blade
BLDN	0229	3.0	Number of blades
C_{L_i}	0230	.46	Induced lift coefficient of wing
η_{P2}	0232	.736	Takeoff, hover, land efficiency
η_{P3}	0233	.837	Climb efficiency
η_{P4}	0234	.700	Descent efficiency
No. Pairs η_{P4} Table	0245	9.0	Number of pairs in η_{P4} efficiency table
M	0235	0.0	
	1236	0.1	
	1237	0.2	
	0238	0.3	
	0239	0.4	} Values of mach number
	0240	0.5	
	0241	0.6	
	0242	0.7	
	0243	0.8	
η_{P4}	0246	0.672	
	0247	0.700	
	0248	0.718	
	0249	0.738	
	0250	0.750	} Values of η_{P4}
	0251	0.760	
	0252	0.765	
	0253	0.758	
	0254	0.751	
XMSNIND	0257	1.0	Transmission sized at either hover or cruise power required (the most critical is chosen)
SHP_{XM}/SHP^*	0258	0.95	Transmission sized at 95% power chosen
ΔSHP_{ACC}	0259	200.0	Accessory horsepower

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
SHP_E/SHP^*	0260	0.9	Engine sized for 90% power; oversized by factor of 1/.9 = 1.111
$V_{R/C}$	0261	500.0	Engine sized at 500 ft/min vertical rate of climb
K_{RC}	0262	2.0	Vertical climb constant choosen for this tilt rotor aircraft

Aircraft Aerodynamics Information Sheet

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
C_{DVTi}	0301	0.0	Profile drag of vertical tail
C_{DHTi}	0302	0.0	Profile drag of horizontal tail
C_{DNi}	0303	0.0	Profile drag of primary engine nacelles
C_{DLNi}	0304	0.0	Profile drag of life engine nacelles
ΔC_D	0305	.16205	Profile drag increment
Δfe FT^2	0307	6.4151	Increment in equivalent flat plat area parasite drag of fuselage (ft^2)
No. of Pairs in Table	0308	2.0	Number of C_L-C_{DWi} Pairs in locations 317-330 and 335-342
K_{LN}	0311	0.0	Lift engine nacelle multiplicative drag factor
K_W	0312	1.0	Wing multiplicative drag factor
K_{HT}	0316	0.0	Horizontal tail multiplicative drag factor
C_{L1}	0317	0.0	Wing lift coefficient
C_{L2}	0318	10.	
$(R_e/l)_i$	0330	$.215\times10^6$	Mean Reynolds number per foot for mission
$C_{l\alpha}$ RAD^{-1}	0331	6.28	Two dimensional wing lift coefficient slope

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
α_{LO} DEG.	0332	-2.8	Angle of attack where the lift equals zero
$(X/_c)_{ps}$	0333	0.45	Position of peak suction location on wing
$(X/_c)_{max_{c/c}}$	0334	.45	Position of maximum thickness on wing
$C_{DWi}(1)$	0335	0.	Wing induced drag coefficient
$C_{DWi}(2)$	0336	0.	

Aircraft Weight Information Sheet

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
W_{FE}LBS	0401	5622.	Weight of fixed equipment, in LBS.
W_{FUL}LBS	0402	1550.	Weight of fixed useful load in LBS.
W_{PL}LBS	0403	5630.	Weight of payload in LBS.
K_{CC}	0404	26.	Cockpit controls weight factor
K_{FW}	0405	.012	Fixed wing controls weight factor
K_H	0406	40.	Constant for flight control hydraulics
K_{SAS}	0407	75.	Stability augmentation system (SAS) weight factor, usually in range of 20-100 LBS
K_{TM}	0408	.015	Tilt mechanism weight factor
K_{UC}	0409	.3	Upper control weight factor
K_{15}	0410	1.0	Cockpit controls weight factor
K_{16}	0411	1.206	Upper controls weight factor
K_{17}	0412	1.25	Hydraulics weights factor
K_{18}	0413	1.0	Fixed wing controls weight factor
K_{19}	0414	1.0	SAS weights factor
K_{20}	0415	1.0	Tilt mechanism weights factor

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
ΔW_{FC}	0417	0.0	Flight controls incremental group weight
ΔW_{P}	0418	100.	Incremental propulsion group weight
ΔW_{ST}	0419	1300.	Structures group incremental weight, in LBS
K_B	0420	170.0	Body weight factor
K_{LG}	0422	.04	Landing gear weight factor, percentage of gross weight
K_{MG}	0423	.8	Main landing gear weight factor
K_{TL}	0424	1.15	Tail load factor
K_{WW}	0426	220.	Detailed wing weight factor, adjusts the constant 220 in $W_W = 220a\ (k)^{.582}$ depending on the complexity of the control surfaces
K_Y	0427	.18	Pitch radius of gyration, feet
K_Z	0428	.28	Yaw radius of gyration, feet
K_8	0433	1.02	Wing weight multiplicative factor
K_9	0434	0.85	Horizontal tail weight factor
K_{10}	0435	0.85	Vertical tail weight factor
K_{DS}	0453	238.6	Drive system weights constant
K_{FS}	0454	.15	Fuel system weights factor
K_{PEI}	0456	.37	Primary engine weight factor
$K_{R/P}$	0457	12.71	Prop/Rotor weights factor
K_{VT}	0458	0.9675	Adjustment for variations in drive system weight
K_2	0459	0.92	Prop group weight factor
K_3	0460	0.93	Drive system weight factor

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
Takeoff, Hover and Landing Information Sheet			
TOLIND	0601 0602	3. 1.	Takeoff and land sharing equal fraction of thrust from primary and lift engines
ATMIND	0611	0.	Takeoff standard day
ATMIND	0612	1.	Landing standard day
PEHF	0621	1.0	Takeoff engine fractional power = 1.0
ΔT_{in}	0632	43.2	Incremental temperature above standard
n_T	0652	1.1221	Thrust to weight
Δt_H	0661	.02083	Takeoff compute in 2 minute increments
Δt_H	0662	.0167	Landing compute in 1 minute increments
N_{II}/N_{IIMAX}	0671	.943	Power turbine speed ratio - takeoff
N_{II}/N_{IIMAX}	0672	.943	Power turbine speed ratio - land
t_H	0681	.041667	Takeoff in 2.5 minutes
t_H	0682	.0333	Landing in 2.0 minutes
$V_{R/C}$	2321 2322	500.0 300.0	Takeoff, hover, or land at specified vertical rate of climb
Cruise Information Sheet			
CRSIND	0801 0802 0803 0809	4. 4. 1.0 4.0	} Cruise indicator
Headwind	0811 0812 0813 0814	0.0 0.0 0.0 0.0	} Cruise headwind

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
ATMIND	0821	0.0	
	0822	0.0	} Cruise @ standard day
	0823	0.0	
	0824	0.0	
ΔR	0831	40.	
	0832	40.	} Increment for calculations
	0833	1.	
	0834	1.	
R_{MAX}	0851	200.	
	0852	400.	Range at end of cruise calculations.
	0853	1.0	
	0854	1.0	
POWIND	0861	2.0	
	0862	2.0	} Cruise limited by normal power
	0863	2.0	
	0864	2.0	
$N_{PSD_{CR}}$	0871	0.0	
	0872	0.0	Number of cruise engines inoperative during cruise
	0873	0.0	
	0874	0.0	
N_{II}/N_{IIMAX}	0881	.6601	
	0882	.6601	} Power turbine operating ratio
	0883	.6601	
	0884	.6601	
$\Delta C_{D_{CRUISE}}$	0891	0.0	
	0892	0.0	No additional aircraft drag during cruise
	0893	0.0	
	0894	0.0	

Loiter Information Sheet

LTRIND	1001	2.0	Loiter for reserve fuel calculation
Δt_L	1011	0.111	Calculate performance in 0.111 hours
ATMIND	1021	0.0	Standard atmosphere
t_L	1031	0.333	Loiter for .333 hours
N_{PSD}	1051	0.0	Loiter with 0 engines inoperative

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
N_{II}/N_{IIMAX}	1061	0.6601	Power turbine operating speed
ΔC_D	1071	0.0	No additional aircraft drag during loiter

Transfer Altitude Sheet

h_{final}	1111 1112 1113	3000. 0.0 20000.	Transfer aircraft to specified altitude

Change in Payload Weight Sheet

ΔW_{PL}	1131	-5520.	Remove 5520 pounds from aircraft
t_{PW}	1141	.00833	Remove weight in 30 seconds

General Performance Information Sheet

GWIND	2201	1.0	Input Δ gross weight
ΔGW	2211	0.0	Aircraft performanced based on gross weight
ATMIND	2221	0.0	Standard atmosphere
C_{LWING}	2231	0.8	Wing lift coefficient
$\Delta C_{D_{CRUISE}}$	2251	0.005	Additoinal drag coefficient added to baseline aircraft
ALT.	2261	1000.	Altitude in feet
T/W	2271	1.122	Thrust to weight ratio
$(N_{II}/N_{IIMAX})_{TO}$	2281	1.0	Power turbine operating speed for takeoff
ΔV	2291	20.0	Performance velocity printout in knots
V_{MAX}	2301	225.0	Maximum cruise velocity in knots
$(N_{II}/N_{IIMAX})_{CR}$	2311	1.0	Power turbine operating speed for cruise

VARIABLE	LOCATION	VALUE ASSIGNED	REMARKS
Run 2			
$\eta_{P_{IND}}$	0200	1.0	Input propeller map
No. of C_T/σ	2351	8.0	Number of C_T/σ in Figure of Merit table
C_T/σ	2352	0.0	
	2353	0.0756	
	2354	0.1667	
	2355	0.3044	} Values of C_T/σ
	2356	0.5322	
	2357	0.7611	
	2358	1.333	
	2359	1.944	
No. of M_{TIP}	2362	3.0	Number of M_{TIP} in Figure of Merit table
M_{TIP}	2363	0.5	
	2364	0.7	Values of M_{TIP}
	2365	0.9	
FMER	2369	0.0	
	2370	0.107	
	2371	0.267	
	2372	0.458	Values of FM corresponding to M_{TIP} = 0.5
	2373	0.686	
	2374	0.753	
	2375	0.721	
		0.500	
	2379	0.0	
	2380	0.107	
	2381	0.267	
	2382	0.458	Values of FM corresponding to M_{TIP} = 0.7
	2383	0.686	
	2384	0.753	
	2385	0.721	
	2386	0.500	
	2389	0.0	
	2390	0.107	
	2391	0.267	
	2392	0.450	Values of FM corresponding to M_{TIP} = 0.9
	2393	0.686	
	2394	0.753	
	2395	0.721	
	2396	0.500	

End of Data

V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

THE FOLLOWING IS A CARD BY CARD REPRODUCTION OF THE INPUT DECK FOR THIS CASE

LOC. CORRESPONDS TO LOCATION NUMBER GIVEN ON INPUT SHEET
NUM STANDS FOR THE NUMBER OF SEQUENTIAL INPUT VALUES STARTING WITH LOC. (MAX. =5)
VAL EQUALS VALUE FOR VARIABLE CORRESPONDING TO LOC.
VAL1 VALUE CORRESPONDING TO LOC.+0001
VAL2 VALUE CORRESPONDING TO LOC.+0002
ETC.

LOC.	NUM	VAL	VAL1	VAL2	VAL3	VAL4
1201	5	.0	.0	.0	2.0000	1.0000
1206	1	.0				
1223	2	1.0260	1.4100			
1301	5	1.8200	.96000E-01	90.000	.30690E-01	1750.0
1306	5	1800.0	2522.0	2645.0	2645.0	8.0000
1311	5	1750.0	1900.0	2150.0	2400.0	2650.0
1316	5	2900.0	3200.0	3550.0	6.0000	.0
1321	5	.20000	.40000	.60000	.70000	1.0000
1326	5	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
1331	5	.70000E-01	.18900	.19000	.19100	.19300
1336	5	.19400	.20000	.39200	.39600	.40200
1341	5	.41100	.42100	.45500	.68800	.70100
1346	5	.71000	.72500	.73600	.84000	1.0050
1351	5	1.0200	1.0420	1.0970	1.1540	1.3800
1356	5	1.2440	1.2740	1.3230	1.3980	1.4600
1361	5	1.8000	1.4390	1.4800	1.5400	1.6540
1366	5	1.7500	2.2500	1.5900	1.6400	1.7000
1371	5	1.8200	1.9600	2.5300	8.0000	1750.0
1376	5	1900.0	2156.0	2400.0	2650.0	2900.0
1381	5	3200.0	3550.0	6.0000	.0	.20000
1386	5	.40000	[illegible]	.70000	1.0000	.12300
1391	5	.12300	.12300	.12300	.12300	.12300
1396	5	.16200	.16200	.16200	.16200	.16200
1401	5	.16200	.24300	.24400	.24400	.24500
1406	5	.24500	.24600	.35500	.35600	.35800
1411	5	.36000	.36100	.37500	.47000	.47700
1416	5	.48500	.49200	.49700	.53500	.56200
1421	5	.57400	.58300	.59900	.62500	.69500
1426	5	.64800	.66400	.67500	.70300	.72700
1431	5	.84500	.74500	.75500	.77200	.81000
1436	5	.84000	.99000	8.0000	1750.0	1900.0
1441	5	2150.0	2400.0	2650.0	2900.0	3200.0
1446	5	3550.0	6.0000	.0	.20000	.40000
1451	5	.60000	.70000	1.0000	.81000	.81000
1456	5	.81000	.81000	.81000	.81000	.84500
1461	5	.84500	.84500	.84500	.84500	.84500
1466	5	.89800	.89800	.89800	.89800	.89800
1471	5	.89800	.95000	.95000	.95000	.95000
1476	5	.95000	.95000	1.0010	1.0010	1.0010
1481	5	1.0010	1.0010	1.0010	1.0480	1.0480
1486	5	1.0480	1.0480	1.0480	1.0480	1.1020
1491	5	1.1020	1.1020	1.1020	1.1020	1.1020

1496	5	1.1540	1.1540	1.1540	1.1540	1.1540
1501	5	1.1540	8.0000	1750.0	1900.0	2150.0
1506	5	2400.0	2650.0	2900.0	3200.0	3550.0
1511	5	6.0000	.0	.20000	.40000	.60000
1516	5	.70000	1.0000	.44900	.44900	.44900
1521	5	.44900	.44900	.44900	.59000	.59000
1526	5	.59000	.59000	.59000	.59000	.74800
1531	5	.75200	.75600	.76100	.76600	.77800
1536	5	.89000	.89500	.90000	.90500	.91000
1541	5	.93200	1.0040	1.0090	1.0140	1.0190
1546	5	1.0240	1.0520	1.0810	1.0870	1.0930
1551	5	1.1000	1.1060	1.1380	1.1450	1.1550
1556	5	1.1650	1.1750	1.1800	1.2100	1.2100
1561	5	1.2200	1.2300	1.2400	1.2500	1.2740
1	5	1.0000	1.0000	.0	1.0000	1.0000
6	5	.0	.0	1.0000	1.0000	1.0000
11	5	.0	.0	.0	35000.	.0
16	5	.0	.0	.0	.0	.68100
21	5	450.00	450.00	3.0000	1.0000	.0
26	5	1.0680	2.0000	4.0000	9.0000	2.0000
31	5	8.0000	9.0000	4 0000	6.0000	.0
36	5	4.0000	.0	9.0000	4.0000	.0
41	2	11.000	100.00			
101	1	6.0000				
103	3	.0	.18000	.18000		
106	5	100.00	.0	1.0000	4.0000	.15000
111	4	22.670	.15000	1.0500	.40000	
116	5	.10000	9.1666	.0	1.0000	.0
122	1	46.500				
126	5	15.000	999.40	7.1666	1.1530	20.000
131	3	.15000	.12800	.32500		
135	2	.0	.90400			
139	3	.0	.0	.0		
200	1	.0				
201	1	1.8200				
204	1	4.0000				
206	1	.97000				
207	5	.0	1.1955	30.800	.94300	.0
212	1	.0				
213	5	2.0000	.0	150.00	.0	.66010
223	4	2.0000	775.18	15.000	35.000	
228	2	95.020	3.0000			
232	3	.73600	.83700	.70000		
235	1	.0				
236	5	.10000	.20000	.30000	.40000	.50000
241	3	.60000	.70000	.80000		
245	1	9.0000				
246	5	.67200	.70000	.71800	.73800	.75000
251	4	.76000	.76500	.75800	.75100	
257	5	1.0000	.95000	200.00	.90000	500.00
262	1	2.0000				
301	5	.0	.0	.0	.0	.16205
307	2	6.4151	2.0000			
311	5	.0	1.0000	.0	.0	.0
316	3	.0	.0	10.000		
330	1	.21505E+06				
331	5	6.2800	-2.8000	.45000	.45000	.0
336	1	.0				
401	3	5622.0	1550.0	5630.0		
404	2	26.000	.12000E-01			

406	5	40.000	75.000	.15000E-01	.30000	1.0000
411	5	1.2060	1.2500	1.0000	1.0000	1.0000
417	4	.0	100.00	1300.0	170.00	
421	5	.0	.40000E-01	.80000	1.1500	2.0000
426	3	220.00	.18000	.28000		
433	3	1.0200	.85000	.85000		
436	4	.85000	.85000	1.0000	1.0000	
450	1	5.7000				
451	5	.0	.10000E+06	238.60	.15000	.0
456	5	.37000	12.710	.96750	.92000	.93000
461	5	1.0000	1.0000	1.0000	1.0000	1.0000
601	2	3.0000	1.0000			
611	2	.0	1.0000			
621	1	1.0000				
632	1	43.200				
652	1	1.1221				
661	2	.20833E-01	.16660E-01			
671	2	.94300	.94300			
681	2	.41667E-01	.33300E-01			
2321	2	300.00	.0			
801	4	4.0000	4.0000	1.0000	4.0000	
811	4	.0	.0	.0	.0	
821	4	.0	.0	.0	.0	
831	4	40.000	40.000	1.0000	1.0000	
851	4	200.00	400.00	1.0000	1.0000	
861	4	2.0000	2.0000	2.0000	2.0000	
871	4	.0	.0	.0	.0	
881	4	.66010	.66010	.66010	.66010	
891	4	.0	.0	.0	.0	
2201	1	1.0000				
2211	1	.0				
2221	1	.0				
2231	1	.80000				
2251	1	.50000E-02				
2261	1	1000.0				
2271	1	1.1220				
2281	1	1.0000				
2291	1	20.000				
2301	1	225.00				
2311	1	1.0000				
1001	1	2.0000				
1011	1	.11100				
1021	1	.0				
1031	1	.33300				
1051	1	.0				
1061	1	.66010				
1071	1	.0				
1111	3	3000.0	.0	20000.		
1131	1	-5520.0				
1141	1	.83300E-02				
1201	5	.0	.0	.0	2.0000	.0
1206	1	.0				
1223	2	1.0260	1.4100			
1301	3	1.8200	.11520	72.000		
1205	1	1.0000				
1224	1	.90000				

```
WG = 0.350000E+05  WFA = 0.0           WFR = 0.0
WG = 0.350000E+05  WFA = 0.320412E+04  WFR = 0.889836E+04
WG = 0.431346E+05  WFA = 0.775536E+04  WFR = 0.112963E+05
WG = 0.565112E+05  WFA = 0.151324E+05  WFR = 0.154612E+05
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V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

S I Z E D A T A THIS RUN CONVERGED IN 4 ITERATIONS

GROSS WEIGHT = 57881. LB

FUSELAGE			
LF	LENGTH	46.5	FT
WF	WIDTH	7.2	FT
SF	WETTED AREA	999.	SQFT
WING			
AR	ASPECT RATIO	6.00	
SW	AREA	578.8	SQFT
B	SPAN	58.9	FT
CBARW	GEOM. MEAN CHORD	9.8	FT
LAMBDA C/4	QUARTER CHORD SWEEP	0.0	DEG
LAMBDA	TAPER RATIO	1.000	
(T/C)R	ROOT THICKNESS	0.180	
(T/C)T	TIP THICKNESS	0.180	
WG/SW	WING LOADING	100.0	LB/SQFT
C BAR / D	MEAN CHORD / PROP. DIA.	0.281	
HOR. TAIL			
ARHT	ASPECT RATIO	4.00	
SHT	AREA	263.3	SQFT
BHT	SPAN	32.5	FT
CBARHT	MEAN CHORD	8.1	FT
(T/C)HT	THICKNESS / CHORD	0.150	
LTH	MOMENT ARM	22.7	FT
VERT. TAIL			
ARVT	ASPECT RATIO	1.15	
SVT	AREA	218.3	SQFT
BVT	SPAN	15.9	FT
CBARVT	MEAN CHORD	13.8	FT
(T/C)VT	THICKNESS / CHORD	0.150	
LTV	MOMENT ARM	20.0	FT
PRIMARY ENG. NACELLE			
LN	LENGTH	0.0	FT
DBARN	MEAN DIAMETER	0.0	FT
SN	WETTED AREA	0.0	SQRT
LIFT ENG. NACELLE			
	NO LIFT PROPULSION SELECTED		
PROPELLER			
D	DIAMETER	35.0	FT
SIGMA R/P	SOLIDITY	0.116	
WG/A	DISC LOADING	30.1	LB/SQFT
CT/SIGMA	THRUST COEFF. / SOLIDITY	0.500	
NR	NO. OF PROPELLERS	2.000	
NO. BLADES	NO. OF BLADES/PROP	3.000	

V A S C O M P II
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W E I G H T S D A T A IN LBS

GLF	GUST LOAD FACTOR	2.977		
STRUCTURES GROUP				
K8 WW	WING	3460.		
K9 WHT	HOR. TAIL	639.		
K10 WVT	VERT. TAIL	412.		
K11 WB	FUSELAGE	3918.		
K12 WLG	LANDING GEAR	1968.		
K13 WLES	LIFT ENGINE SECTION	0.		
K14 WPES	PRIMARY ENGINE SECTION	0.		
DELTA WST	STRUCTURE WEIGHT INCREMENT	1300.		
WST	TOTAL STRUCTURE WEIGHT	11696.		
PROPULSION GROUP				
K2 WR/P	ROTOR OR PROP	2640.		
K3 WDS	DRIVE SYSTEM	4922.		
K4 WEL	LIFT ENGINES	0.		
K5 WEP	PRIMARY ENGINES	2778.		
K6 WLEI	LIFT ENGINE INSTALLATION	0.		
K7 WPEI	PRIMARY ENGINE INSTALLATION	1028.		
K21 WFS	FUEL SYSTEM	2382.		
DELTA WP	PROPULSION GROUP WEIGHT INCREMENT	100.		
WP	TOTAL PROPULSION GROUP WEIGHT	13849.		
FLIGHT CONTROLS GROUP				
K15 WCC	COCKPIT CONTROLS	137.		
K16 WUC	UPPER CONTROLS	1038.		
K17 WH	HYDRAULICS	839.		
K18 WFW	FIXED WING CONTROLS	695.		
K19 WSAS	SAS	75.		
K20 WTM	TILT MECHANISM	868.		
DELTA WFC	CONTROL WEIGHT INCREMENT	0.		
WFC	TOTAL CONTROL WEIGHT	3652.		
WFE	WEIGHT OF FIXED EQUIPMENT	5622.		
WE	WEIGHT EMPTY	34820.		
WFUL	FIXED USEFUL LOAD	1550.		
OWE	OPERATING WEIGHT EMPTY	36370.		
WPL	PAYLOAD	5630.		
(WF)A	FUEL	15881.	(WF)W	15881.
WG	GROSS WEIGHT	57881.		

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                          V A S C O M P  II
          V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93

  P R O P U L S I O N  D A T A
          PRIMARY PROPULSION CYCLE NO.    1.820
                  TURBOSHAFT ENGINE

                   4.  ENGINES

              BHP*P          MAX. STANDARD S.L. STATIC H.P.         21611.     H.P.

              ENGINE SIZED FOR TAKEOFF AT T/W = 1.20
               90.0 PERCENT,MILITARY POWER SETTING
              VERTICAL RATE OF CLIMB =  500.0 FT/MIN
              H =      0. FT, TEMPERATURE = 89.80 DEG F,
              AND  0.0  ENGINES INOPERATIVE.
              NO CRUISE CONDITION SPECIFIED.

          NO LIFT ENGINE CYCLE SELECTED

          XMSN SIZED AT  95. PERCENT OF ROTOR HOVER POWER REQUIRED
          AT H=    0. FT,TEMP= 89.80 DEG.F.,100.0  PERCENT HOVER RPM
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V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

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A E R O D Y N A M I C S   D A T A
          FE          TOTAL EFFECTIVE FLATPLATE AREA       100.210     SQFT
          SWET        TOTAL WETTED AREA                      3050.     SQFT
          CBARF       MEAN SKIN FRICTION COEFF.           0.032858

D R A G   B R E A K D O W N         IN  SQFT
          FEW         WING FE                                  6.0
          FEF         FUSELAGE FE                              6.415
          FEVT        VERT. TAIL FE                            0.0
          FEHT        HOR.  TAIL FE                            0.0
          FEN         PRIMARY ENG. NACELLE FE                  0.0
          FELN        LIFT ENG. NACELLE FE                     0.0
          DELTA FE    INCREMENTAL FE                          93.795

A E R O D Y N A M I C   C O E F F .
          A1                                               0.67820
          A2                                              -0.06600
          A3                                               0.08608
          A4                                               0.13500
          A5                                               0.17313
          A6                                               1.30180
          A7                                               0.06734
          CL ALPHA    3-D LIFT SLOPE                       5.20400     PER RADIAN
          E           OSWALD   FACTOR                      0.78782
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V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

MISSION PERFORMANCE DATA

TAKEOFF, HOVER, OR LAND AT PETF = 1.000 LETF = 0.0 FOR 0.042 HRS.
VERTICAL RATE OF CLIMB = 300.0 FT/MIN TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	LETF	THRUST TO WEIGHT	FM	BHP	CT	VTIP (FPS)
0.0	0.0	0.0	57881.	0.	0.0	2526.6	Q	1.000	0.0	1.363	0.736	19129.	0.2376	750.
0.021	0.0	200.1	57680.	0.	0.0	2526.6	Q	1.000	0.0	1.367	0.736	19129.	0.2376	750.
0.042	0.0	400.2	57480.	0.	0.0	2526.6	Q	1.000	0.0	1.372	0.736	19129.	0.2376	750.
0.042	0.0	400.2	57480.	0.	0.0	2526.6	Q	1.000	0.0	1.372	0.736	19129.	0.2376	750.

CRUISE AT SPEED FOR 99 PER CENT BEST RANGE WITH HEADWIND OF 0.0 KNOTS TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	SPEC. RANGE (NMPP)	ETAP PROP
CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW (LBS/HR)	BHP		THRUST (LBS)	CP	CT	J	VTIP (FPS)	
0.042	0.0	400.2	57480.	0.	172.0	2236.6	P	0.801	172.0	0.260	0.613	.02647	0.730
0.990	0.2391	4.140	57480.	13883.	6503.	10551.		14145.	0.2071	0.0870	1.738	525.0	
0.274	40.00	1911.5	55969.	0.	171.0	2225.6	P	0.781	171.0	0.258	0.614	.02678	0.730
0.975	0.2372	4.112	55969.	13611.	6391.	10293.		13873.	0.2021	0.0853	1.728	525.0	
0.508	80.00	3405.3	54475.	0.	170.5	2217.1	P	0.766	170.5	0.258	0.615	.02706	0.730
0.955	0.2345	4.072	54475.	13380.	6305.	10095.		13643.	0.1982	0.0839	1.723	525.0	
0.743	120.00	4883.2	52997.	0.	169.0	2204.4	P	0.743	169.0	0.255	0.616	.02739	0.729
0.946	0.2333	4.052	52997.	13078.	6175.	9793.		13344.	0.1922	0.0821	1.708	525.0	
0.979	160.00	6343.6	51537.	0.	166.5	2187.5	P	0.713	166.5	0.252	0.616	.02775	0.728
0.947	0.2336	4.056	51537.	12706.	6004.	9391.		12976.	0.1844	0.0798	1.683	525.0	
1.220	200.00	7785.2	50095.	0.	164.5	2173.3	P	0.687	164.5	0.249	0.616	.02808	0.728
0.943	0.2331	4.048	50095.	12376.	5862.	9052.		12649.	0.1777	0.0778	1.663	525.0	
1.220	200.00	7785.2	50095.	0.	164.5	2173.3	P	0.687	164.5	0.249	0.616	.02808	0.728
0.943	0.2331	4.048	50095.	12376.	5862.	9052.		12649.	0.1777	0.0778	1 663	525.0	

TRANSFER ALTITUDE TO 3000. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
1.220	200.00	7785.2	50095.	0.
1.220	200.00	7785.2	50095.	3000.

TAKEOFF, HOVER, OR LAND AT T/W = 1.122 FOR 0.033.HRS.

VERTICAL RATE OF CLIMB = 0.0 FT/MIN TEMPERATURE = 91.5 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	LETF	THRUST TO WEIGHT	FM	BHP	CT	VTIP (FPS)
1.220	200.00	7785.2	50095.	3000.	0.0	2608.6	P	0.951	0.0	1.122	0.736	15376.	0.2008	750.
1.236	200.00	7920.9	49960.	3000.	0.0	2608.6	P	0.951	0.0	1.122	0.736	15376.	0.2003	750.
1.253	200.00	8056.5	49824.	3000.	0.0	2608.6	P	0.951	0.0	1.122	0.736	15376.	0.1997	750.

CHANGE PAYLOAD, REMOVE 5520. LB.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
1.253	200.00	8056.5	49824.	3000.
1.261	200.00	8056.5	44304.	3000.

TRANSFER ALTITUDE TO 0. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
1.261	200.00	8056.5	44304.	3000.
1.261	200.00	8056.5	44304.	0.

CRUISE AT SPEED FOR 99 PER CENT BEST RANGE WITH HEADWIND OF 0.0 KNOTS TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	SPEC. RANGE (NMPP)	ETAP PROP
CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW (LBS/HR)	BHP		THRUST (LBS)	CP	CT	J	VTIP (FPS)	
1.261	200.00	8056.5	44304.	0.	158.0	2119.8	P	0.599	158.0	0.239	0.619	.02948	0.726
0.904	0.2282	3.963	44304.	11180.	5364.	7901.		11464.	0.1551	0.0705	1.597	525.0	
1.514	240.00	9413.5	42947.	0.	157.0	2109.0	P	0.584	157.0	0.237	0.620	.02981	0.725
0.888	0.2262	3.925	42947.	10942.	5272.	7693.		11229.	0.1510	0.0690	1.587	525.0	
1.769	280.00	10755.5	41605.	0.	156.0	2098.3	P	0.568	156.0	0.236	0.621	.03013	0.725
0.871	0.2242	3.885	41605.	10709.	5182.	7490.		10997.	0.1470	0.0676	1.577	525.0	
2.026	320.00	12083.1	40277.	0.	155.0	2087.8	P	0.553	155.0	0.234	0.622	.03045	0.725
0.854	0.2223	3.843	40277.	10480.	5094.	7291.		10770.	0.1431	0.0662	1.567	525.0	
2.284	360.00	13396.6	38964.	0.	154.5	2079.9	P	0.542	154.5	0.233	0.623	.03075	0.725
0.832	0.2197	3.786	38964.	10292.	5029.	7143.		10583.	0.1402	0.0651	1.562	525.0	
2.543	400.00	14697.6	37663.	0.	153.5	2069.7	P	0.528	153.5	0.232	0.624	.03106	0.724
0.815	0.2178	3.740	37663.	10071.	4946.	6953.		10364.	0.1365	0.0637	1.551	525.0	
2.543	400.00	14697.6	37663.	0.	153.5	2069.7	P	0.528	153.5	0.232	0.624	.03106	0.724
0.815	0.2178	3.740	37663.	10071.	4946.	6953.		10364.	0.1365	0.0637	1.551	525.0	

LOITER FOR 0.333 HRS. FOR RESERVE FUEL TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	FUEL RATE (LB-HR)	ETAP PROP

CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW (LBS/HR)	BHP		THRUST (LBS)	CP	CT	J	VTIP (FPS)	ETAP
2.543	400.00	14697.6	37663.	0.	83.0	1883.8	P	0.281	83.0	0.125	0.494	3633.	0.705
2.786	0.6958	4.004	37663.	9406.	3633.	3706.		9938.	0.0728	0.0611	0.839	525.0	0.705
2.654	400.00	15100.9	37260.	0.	83.0	1880.8	P	0.277	83.0	0.125	0.496	3614.	0.705
2.756	0.6847	4.025	37260.	9256.	3614.	3650.		9788.	0.0717	0.0602	0.839	525.0	0.705
2.765	400.00	15502.1	36858.	0.	82.0	1877.9	P	0.273	82.0	0.124	0.494	3595.	0.704
2.793	0.6986	3.999	36858.	9218.	3595.	3596.		9756.	0.0706	0.0600	0.829	525.0	0.704
2.876	400.00	15901.2	36459.	0.	82.0	1875.0	P	0.269	82.0	0.124	0.496	3577.	0.704
2.763	0.6873	4.020	36459.	9068.	3577.	3541.		9606.	0.0695	0.0591	0.829	525.0	0.704
2.876	400.00	1590[illegible].2	36459.	0.	82.0	1875.0	P	0.269	82.0	0.124	0.496	3577.	0.704
2.763	0.6873	4.020	36459.	9068	3577.	3541.		9606.	0.0695	0.0591	0.829	525.0	0.704

MISSION FUEL REQUIRED = 14697.63
RESERVE FUEL REQUIRED = 1203.60
TOTAL FUEL REQUIRED = 15901.23

V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

MISSION PERFORMANCE DATA

CRUISE AT -NORMAL ENGINE RATING TEMPERATURE =. 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	SPEC. RANGE (NMPP)	ETAP PROP
CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW (LBS/HR)	BHP		THRUST (LBS)	CP	CT	J	VTIP (FPS)	
0.0	0.0	0.0	57881.	0.	192.5	2349.7	Q	1.000	192.5	0.291	0.626	.02503	0.736
0.796	0.2158	3.688	57881.	15695.	7693.	13181.		15920.	0.2588	0.0979	1.946	525.0	
0.005	1.00	40.0	57841.	0.	192.5	2349.7	Q	1.000	192.5	0.291	0.626	.02503	0.736
0.795	0.2157	3.686	57841.	15693.	7693.	13181.		15918.	0.2588	0.0979	1.946	525.0	

MISSION FUEL REQUIRED = 39.96
RESERVE FUEL REQUIRED = 0.0
TOTAL FUEL REQUIRED = 39.96

VASCOMP SAMPLE CASE NO. 3 RUN 1

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V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

MISSION PERFORMANCE DATA

TRANSFER ALTITUDE TO 20000. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
0.0	0.0	0.0	57881.	0.
0.0	0.0	0.0	57881.	20000.

CRUISE AT SPEED FOR 99 PER CENT BEST RANGE WITH HEADWIND OF 0.0 KNOTS TEMPERATURE = -12.3 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	SPEC. RANGE (NMPP)	ETAP PROP
CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW (LBS/HR)	BHP		THRUST (LBS)	CP	CT	J	VTIP (FPS)	
*** CAUTION - SPEED LIMITED BY POWER AVAILABLE AT SPECIFIED POWER SETTING ***													
0.0	0.0	0.0	57881.	20000.	197.5	2522.0	T	0.941	144.2	0.321	0.585	.03427	0.741
1.419	0.3088	4.596	57881.	12592.	5774.	10808.		12801.	0.3982	0.1477	1.996	525.0	
0.005	1.00	29.2	57851.	20000.	197.5	2522.0	T	0.941	144.2	0.321	0.585	.03429	0.741
1.419	0.3086	4.596	57851.	12587.	5774.	10808.		12801.	0.3982	0.1477	1.996	525.0	
0.005	1.00	29.2	57851.	20000.	197.5	2522.0	T	0.941	144.2	0.321	0.585	.03429	0.741
1.419	0.3086	4.596	57851.	12587.	5774.	10808.		12801.	0.3982	0.1477	1.996	525.0	

MISSION FUEL REQUIRED = 29.18
RESERVE FUEL REQUIRED = 0.0
TOTAL FUEL REQUIRED = 29.18

V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

MISSION PERFORMANCE DATA

GROSS WEIGHT = 57881. LB
ALTITUDE = 1000.0 FT
TEMPERATURE = 55.434 DEG.,F.

W/DELTA =.60018. LB
DELTRTH = 0.961
DELTA = 0.964
THETA = 0.993

TAS (KTS)	TOTAL FUEL FLOW (LBS/HR)		THRUST TO WEIGHT	EAS (KTS)	FUEL FLOW PRIM. ENG (LBS/HR)	TURB. TEMP. (R)	PETF OR PEHF	MACH	MACH DIV	SPEC. RANGE (NMPP)	BHP	FM
CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW LIFT ENG. (LBS/HR)	J	LETF	CP	CT	VTIP (FPS)	NET THRUST	ETAP PROP
0.0	8000.9		1.122	0.0	8000.9	2394.7	0.720	0.0	0.678	.0	14342.	0.736
----	----	----	57881.	----	0.0	0.0	0.0	0.0822	0.1792	795.3	0.	----
55.1	6508.6		----	54.3	6508.6	2247.6	0.514	0.084	0.018	.008469	10236.	----
9.996	6.9100	1.447	57881.	40010.	0.0	0.368	0.0	0.0614	0.1160	795.3	0.	0.695
60.0	6243.7		----	59.1	6243.7	2220.9	0.476	0.091	0.121	.009610	9484.	----
8.437	4.9720	1.697	57881.	34108.	0.0	0 400	0.0	0.0569	0.0991	795.3	0.	0.697
80.0	5601.7		----	78.8	5601.7	2155.4	0.383	0.121	0.365	.014281	7635.	----
4.746	1.6950	2.800	57881.	20671.	0.0	0.534	0.0	0.0458	0.0603	795.3	0.	0.704
100.0	5381.3		----	98.5	5381.3	2132.0	0.351	0.152	0.478	.018583	6996.	----
3.037	0.7994	3.800	57881.	15233.	0.0	0.667	0.0	0.0419	0.0446	795.3	0.	0.709
120.0	5435.2		----	118.3	5435.2	2137.7	0.360	0.182	0.539	.022078	7164.	----
2.109	0.4778	4.415	57881.	13109.	0.0	0.801	0.0	0.0429	0.0383	795.3	0.	0.715
140.0	5708.7		----	138.0	5708.7	2166.0	0.402	0.212	0.576	.024524	8005.	----
1.550	0.3399	4.560	57881.	12693.	0.0	0.934	0.0	0.0480	0.0370	795.3	0.	0.720
160.0	6200.2		----	157.7	6200.2	2216.2	0.476	0.243	0.600	.025806	9478.	----
1.187	0.2729	4.347	57881.	13314.	0.0	1.067	0.0	0.0568	0.0387	795.3	0.	0.727
180.0	6931.4		----	177.4	6931.4	2288.8	0.582	0.273	0.616	.025969	11592.	----
0.937	0.2373	3.950	57881.	14652.	0.0	1.201	0.0	0.0695	0.0424	795.3	0.	0.733
200.0	7938.1		----	197.1	7938.1	2385.0	0.721	0.303	0.628	.025195	14374.	----
0.759	0.2170	3.500	57881.	16537.	0.0	1.334	0.0	0.0862	0.0477	795.3	0.	0.738
220.0	9300.7		----	216.8	9300.7	2499.4	0.899	0.334	0.637	.023654	17908.	----
0.628	0.2047	3.067	57881.	18875.	0.0	1.468	0.0	0.1073	0.0543	795.3	0.	0.742
225.0	9698.4		----	221.7	9698.4	2534.9	0.949	0.341	0.639	.023200	18909.	----

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0.600   0.2024    2.965     57881.   19523.     0.0   1.501    0.0     0.1133   0.0561   795.3        0.      0.745

          MAIN TRANSMISSION TORQUE LIMIT (ALL ENGINES OPERATING) OCCURS AT
                                          V                 =  227.7 KTAS
                                          MAIN ROTOR VTIP =  795.3 FT/SEC
                                          MAIN ROTOR RPM  =  434.0
                                          POWER           = 19956. SHP
                                          TORQUE          =  241501. FT-LB


               V(MAX PWR)          =  227.7 KTAS  SPEC.RANGE = 0.0223 NM/LB   Q
               V(MIL PWR)          =  227.7 KTAS  SPEC.RANGE = 0.0223 NM/LB   Q
               V(NRP)              =  222.1 KTAS  SPEC.RANGE = 0.0228 NM/LB   T
               V(BEST RANGE)       =  173.0 KTAS  SPEC.RANGE = 0.0254 NM/LB   P
               V(99 PERCENT BR)    =  187.5 KTAS  SPEC.RANGE = 0.0252 NM/LB   P
               V(BEST ENDURANCE)   =  102.7 KTAS  FUEL FLOW  =  5443. LB/HR   P

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END  OF  SUCCESSFUL  CASE

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V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

THE FOLLOWING IS A CARD BY CARD REPRODUCTION OF THE INPUT DECK FOR THIS CASE

LOC. CORRESPONDS TO LOCATION NUMBER GIVEN ON INPUT SHEET
NUM STANDS FOR THE NUMBER OF SEQUENTIAL INPUT VALUES STARTING WITH LOC. (MAX. =5)
VAL EQUALS VALUE FOR VARIABLE CORRESPONDING TO LOC.
VAL1 VALUE CORRESPONDING TO LOC.+0001
VAL2 VALUE CORRESPONDING TO LOC.+0002
ETC.

LOC.	NUM	VAL	VAL1	VAL2	VAL3	VAL4
200	1	1.0000				
256	1	7403.3				
2351	1	7.0000				
2352	5	.0	.75600E-01	.16670	.30440	.53220
2357	2	.76110	1.3330			
2362	1	3.0000				
2363	3	.50000	.70000	.90000		
2369	5	.0	.10700	.26700	.45810	.68600
2374	2	.75300	.72110			
2379	5	.0	.10700	.26700	.45810	.68600
2384	2	.75300	.72110			
2389	5	.0	.10700	.26700	.45810	.68600
2394	2	.75300	.72110			
1700	1	7403.3				
1701	1	11.000				
1702	5	.10000E-01	.50000	1.0000	1.5000	2.0000
1707	5	2.5000	3.0000	3.5000	4.0000	4.5000
1712	1	9.0000				
1722	1	12.000				
1723	5	.14000E-03	.68000E-02	.15000E-01	.27400E-01	.47900E-01
1728	5	.68500E-01	.82100E-01	.95700E-01	.12000	.15000
1733	2	.17500	.60000			
1743	5	.39000E-02	.41000E-02	.48000E-02	.65000E-02	.82000E-02
1748	5	.11000E-01	.15500E-01	.21500E-01	.35000E-01	.57000E-01
1753	1	.85000E-01				
1763	5	.42000E-02	.79000E-02	.10700E-01	.15600E-01	.20600E-01
1768	5	.26300E-01	.33700E-01	.45100E-01	.69900E-01	.10550
1773	1	.15300				
1783	5	.55000E-02	.12000E-01	.18500E-01	.28000E-01	.36800E-01
1788	5	.47000E-01	.59500E-01	.74000E-01	.10100	.15550
1793	1	.22300				
1803	5	.79000E-02	.18400E-01	.31400E-01	.46900E-01	.62300E-01
1808	5	.78400E-01	.95800E-01	.11870	.15710	.23350
1813	1	.33900				
1823	5	.12200E-01	.30500E-01	.53500E-01	.79500E-01	.10530
1828	5	.13200	.16030	.19410	.25400	.35750
1833	1	.52500				
1843	5	.19000E-01	.44200E-01	.76900E-01	.11350	.14950
1848	5	.18710	.22630	.27270	.35360	.48950
1853	1	.70450				
1863	5	.24600E-01	.54200E-01	.93200E-01	.13680	.17980
1868	5	.22460	.27120	.32690	.42820	.59700

1873	1	.90600				
1883	5	.31500E-01	.64900E-01	.11050	.16080	.21070
1888	5	.26270	.31690	.38200	.50570	.72350
1893	1	1.0980				
1903	5	.46000E-01	.87000E-01	.14480	.20800	.27050
1908	5	.33800	.40450	.48000	.65200	.93300
1913	1	1.3900				
1923	5	.75000E-01	.12800	.19150	.26600	.35000
1928	5	.44000	.53600	.67000	.87700	1.2320
1933	1	1.8200				
1943	5	.11700	.17800	.25600	.34800	.45300
1948	5	.56750	.68900	.85300	1.1130	1.5230
1953	1	2.1000				
1963	5	.16600	.24400	.34250	.46100	.59700
1968	5	.74600	.90000	1.1110	1.4325	1.8940
1973	1	2.4300				

WG = 0.350000E+05 WFA = 0.158807E+05 WFR = 0.291773E+02
WG = 0.350000E+05 WFA = 0.959688E+03 WFR = 0.873029E+04
WG = 0.461008E+05 WFA = 0.792232E+04 WFR = 0.10[illegible]142E+05
WG = 0.530510E+05 WFA = 0.122040E+05 WFR = 0.123707E+05

V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM   B-93

S I Z E D A T A THIS RUN CONVERGED IN 4 ITERATIONS

GROSS WEIGHT = 53461. LB

FUSELAGE			
LF	LENGTH	46.5	FT
WF	WIDTH	7.2	FT
SF	WETTED AREA	999.	SQFT
WING			
AR	ASPECT RATIO	6.00	
SW	AREA	534.6	SQFT
B	SPAN	56.6	FT
CBARW	GEOM. MEAN CHORD	9.4	FT
LAMBDA C/4	QUARTER CHORD SWEEP	0.0	DEG
LAMBDA	TAPER RATIO	1.000	
(T/C)R	ROOT THICKNESS	0.180	
(T/C)T	TIP THICKNESS	0.180	
WG/SW	WING LOADING	100.0	LB/SQFT
C BAR / D	MEAN CHORD / PROP. DIA.	0.270	
HOR. TAIL			
ARHT	ASPECT RATIO	4.00	
SHT	AREA	233.7	SQFT
BHT	SPAN	30.6	FT
CBARHT	MEAN CHORD	7.6	FT
(T/C)HT	THICKNESS / CHORD	0.150	
LTH	MOMENT ARM	22.7	FT
VERT. TAIL			
ARVT	ASPECT RATIO	1.15	
SVT	AREA	193.8	SQFT
BVT	SPAN	14.9	FT
CBARVT	MEAN CHORD	13.0	FT
(T/C)VT	THICKNESS / CHORD	0.150	
LTV	MOMENT ARM	20.0	FT
PRIMARY ENG. NACELLE			
LN	LENGTH	0.0	FT
DBARN	MEAN DIAMETER	0.0	FT
SN	WETTED AREA	0.0	SQRT
LIFT ENG. NACELLE			
	NO LIFT PROPULSION SELECTED		
PROPELLER			
D	DIAMETER	35.0	FT
SIGMA R/P	SOLIDITY	0.116	
WG/A	DISC LOADING	27.8	LB/SQFT
CT/SIGMA	THRUST COEFF. / SOLIDITY	0.462	
NR	NO. OF PROPELLERS	2.000	
NO. BLADES	NO. OF BLADES/PROP	3.000	

V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

W E I G H T S D A T A IN LBS

GLF	GUST LOAD FACTOR	2.985
STRUCTURES GROUP		
K8 WW	WING	3157.
K9 WHT	HOR. TAIL	574.
K10 WVT	VERT. TAIL	366.
K11 WB	FUSELAGE	3865.
K12 WLG	LANDING GEAR	1818.
K13 WLES	LIFT ENGINE SECTION	0.
K14 WPES	PRIMARY ENGINE SECTION	0.
DELTA WST	STRUCTURE WEIGHT INCREMENT	1300.
WST	TOTAL STRUCTURE WEIGHT	11080.
PROPULSION GROUP		
K2 WR/P	ROTOR OR PROP	2666.
K3 WDS	DRIVE SYSTEM	5038.
K4 WEL	LIFT ENGINES	0.
K5 WEP	PRIMARY ENGINES	2851.
K6 WLEI	LIFT ENGINE INSTALLATION	0.
K7 WPEI	PRIMARY ENGINE INSTALLATION	1055.
K21 WFS	FUEL SYSTEM	1868.
DELTA WP	PROPULSION GROUP WEIGHT INCREMENT	100.
WP	TOTAL PROPULSION GROUP WEIGHT	13579.
FLIGHT CONTROLS GROUP		
K15 WCC	COCKPIT CONTROLS	133.
K16 WUC	UPPER CONTROLS	1049.
K17 WH	HYDRAULICS	846.
K18 WFW	FIXED WING CONTROLS	642.
K19 WSAS	SAS	75.
K20 WTM	TILT MECHANISM	802.
DELTA WFC	CONTROL WEIGHT INCREMENT	0.
WFC	TOTAL CONTROL WEIGHT	3545.
WFE	WEIGHT OF FIXED EQUIPMENT	5622.
WE	WEIGHT EMPTY	33826.
WFUL	FIXED USEFUL LOAD	1550.
OWE	OPERATING WEIGHT EMPTY	35376.
WPL	PAYLOAD	5630.
(WF)A	FUEL	12454. (WF)W 12454.
WG	GROSS WEIGHT	53461.

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                         V A S C O M P  II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM    B-93


P R O P U L S I O N  D A T A
          PRIMARY PROPULSION CYCLE NO.     1.820
                  TURBOSHAFT ENGINE

                   4.  ENGINES

              BHP*P        MAX. STANDARD S.L. STATIC H.P.        22252.     H.P.

              ENGINE SIZED FOR TAKEOFF AT T/W = 1.20
               90.0 PERCENT,MILITARY POWER SETTING
              VERTICAL RATE OF CLIMB =  500.0 FT/MIN
              H =      0. FT, TEMPERATURE = 89.80 DEG F,
              AND  0.0  ENGINES INOPERATIVE.
              NO CRUISE CONDITION SPECIFIED.


          NO LIFT ENGINE CYCLE SELECTED

          XMSN SIZED AT  95. PERCENT OF ROTOR HOVER POWER REQUIRED
          AT H=    0. FT,TEMP= 89.80 DEG.F.,100.0  PERCENT HOVER RPM
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V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM   B-93

A E R O D Y N A M I C S D A T A

FE	TOTAL EFFECTIVE FLATPLATE AREA	93.049	SQFT
SWET	TOTAL WETTED AREA	2856.	SQFT
CBARF	MEAN SKIN FRICTION COEFF.	0.032580	

D R A G B R E A K D O W N   IN SQFT

FEW	WING FE	0.0
FEF	FUSELAGE FE	6.415
FEVT	VERT. TAIL FE	0.0
FEHT	HOR. TAIL FE	0.0
FEN	PRIMARY ENG. NACELLE FE	0.0
FELN	LIFT ENG. NACELLE FE	0.0
DELTA FE	INCREMENTAL FE	86.633

A E R O D Y N A M I C C O E F F .

A1		0.67820	
A2		-0.06600	
A3		0.08608	
A4		0.13500	
A5		0.17405	
A6		1.31108	
A7		0.06734	
CL ALPHA	3-D LIFT SLOPE	5.20400	PER RADIAN
E	OSWALD FACTOR	0.78782	

V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM   B-93

MISSION PERFORMANCE DATA

TAKEOFF, HOVER, OR LAND AT PETF = 1.000 LETF = 0.0   FOR 0.042 HRS.
VERTICAL RATE OF CLIMB = 300.0 FT/MIN   TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	LETF	THRUST TO WEIGHT	FM	BHP	CT	VTIP (FPS)
0.0	0.0	0.0	53461.	0.	0.0	2526.6	Q	1.000	0.0	1.361	0.633	19692.	0.2193	750.
0.021	0.0	206.0	53255.	0.	0.0	2526.6	Q	1.000	0.0	1.367	0.633	19692.	0.2193	750.
0.042	0.0	412.0	53049.	0.	0.0	2526.6	Q	1.000	0.0	1.372	0.633	19692.	0.2193	750.
0.042	0.0	412.1	53049.	0.	0.0	2526.6	Q	1.000	0.0	1.372	0.633	19692.	0.2193	750.

CRUISE AT SPEED FOR 99 PER CENT BEST RANGE WITH HEADWIND OF   0.0 KNOTS   TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	SPEC. RANGE (NMPP)	ETAP PROP
CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW (LBS/HR)	BHP		THRUST (LBS)	CP	CT	J	VTIP (FPS)	
0.042	0.0	412.1	53049.	0.	200.5	2265.1	P	0.549	200.5	0.303	0.630	.02865	0.898
0.728	0.2147	3.390	53049.	15647.	7001.	11258.		15930.	0.0636	0.0427	1.338	795.3	
0.052	2.00	481.9	52979.	0.	200.5	2264.9	P	0.549	200.5	0.303	0.630	.02866	0.898
0.727	0.2147	3.387	52979.	15640.	7000.	11253.		15923.	0.0635	0.0427	1.338	795.3	
0.052	2.00	481.9	52979.	0.	200.5	2264.9	P	0.549	200.5	0.303	0.630	.02866	0.898
0.727	0.2147	3.387	52979.	15640.	7000.	11253.		15923.	0.0635	0.0427	1.338	795.3	

TRANSFER ALTITUDE TO   3000. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
0.052	2.00	481.9	52979.	0.
0.052	2.00	481.9	52979.	3000.

TAKEOFF, HOVER, OR LAND AT T/W = 1.122 FOR 0.033 HRS.
VERTICAL RATE OF CLIMB =   0.0 FT/MIN   TEMPERATURE = 91.5 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	LETF	THRUST TO WEIGHT	FM	BHP	CT	VTIP (FPS)
0.052	2.00	481.9	52979.	3000.	0.0	2602.5	P	0.941	0.0	1.122	0.633	15663.	0.2124	750.
0.068	2.00	620.6	52840.	3000.	0.0	2600.3	P	0.937	0.0	1.122	0.633	15602.	0.2118	750.
0.085	2.00	758.9	52702.	3000.	0.0	2598.1	P	0.933	0.0	1.122	0.633	15542.	0.2113	750.

CHANGE PAYLOAD, REMOVE   5520. LB.

FUEL   PRES.

TIME (HRS)	RANGE (N.M.)	USED (LBS)	WEIGHT (LBS.)	ALT. (FT)
0.085	2.00	758.9	52702.	3000.
0.093	2.00	758.9	47182.	3000.

TRANSFER ALTITUDE TO 0. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
0.093	2.00	758.9	47182.	3000.
0.093	2.00	758.9	47182.	0.

CRUISE AT SPEED FOR 99 PER CENT BEST RANGE WITH HEADWIND OF 0.0 KNOTS TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	SPEC. RANGE (NMPP)	ETAP PROP
CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW (LBS/HR)	BHP		THRUST (LBS)	CP	CT	J	VTIP (FPS)	
0.093	2.00	758.9	47182.	0.	173.0	2088.7	P	0.555	173.0	0.261	0.621	.03297	0.911
0.870	0.2250	3.866	47182.	12205.	5251.	7535.		12538.	0.1479	0.0771	1.748	525.0	
0.313	40.00	1911.3	46030.	0.	172.0	2079.9	P	0.543	172.0	0.260	0.622	.03325	0.911
0.858	0.2237	3.838	46030.	11993.	5176.	7365.		12328.	0.1446	0.0758	1.738	525.0	
0.545	80.00	3114.3	44827.	0.	171.5	2073.2	P	0.533	171.5	0.259	0.623	.03352	0.912
0.841	0.2217	3.793	44827.	11817.	5121.	7238.		12153.	0.[illegible]421	0.0747	1.733	525.0	
0.779	120.00	4307.7	43633.	0.	171.0	2066.7	P	0.524	171.0	0.258	0.624	.03378	0.912
0.823	0.2197	3.747	43633.	11643.	5067.	7113.		11980.	0.1396	0.0737	1.728	525.0	
1.013	160.00	5492.0	42449.	0.	170.5	2060.3	P	0.515	170.5	0.258	0.625	.03403	0.912
0.806	0.2178	3.700	42449.	11474.	5014.	6991.		11811.	0.1372	0.0726	1.723	525.0	
1.247	200.00	6667.4	41274.	0.	170.0	2054.0	P	0.506	170.0	0.257	0.626	.03428	0.912
0.788	0.2159	3.650	41274.	11307.	4962.	6872.		11646.	0.1349	0.0716	1.718	525.0	
1.483	240.00	7834.1	40107.	0.	169.0	2045.5	P	0.495	169.0	0.255	0.627	.03456	0.912
0.[illegible]75	0.2145	3.612	40107.	11102.	4894.	6713.		11443.	0.1318	0.0704	1.708	525.0	
1.719	280.00	8991.5	38949.	0.	168.5	2039.4	P	0.486	168.5	0.255	0.628	.03480	0.912
0.757	0.2126	3.560	38949.	10942.	4845.	6599.		11284.	0.1296	0.0694	1.703	525.0	
1.957	320.00	10149.9	37800.	0.	168.0	2033.5	P	0.478	168.0	0.254	0.629	.03504	0.912
0.739	0.2108	3.505	37800.	10785.	4798.	6489.		11128.	0.1274	0.0684	1.698	525.0	
2.195	360.00	11282.5	36658.	0.	167.5	2027.6	P	0.470	167.5	0.253	0.631	.03527	0.912
0.721	0.2090	3.448	36658.	10630.	4752.	6380.		10974.	0.1253	0.0675	1.693	525.0	
2.434	400.00	12416.6	35524.	0.	167.0	2021.9	P	0.462	167.0	0.252	0.632	.03550	0.912
0.703	0.2073	3.390	35524.	10479.	4708.	6275.		10824.	0.1232	0.0666	1.688	525.0	
2.434	400.00	12416.6	35524.	0.	167.0	2021.9	P	0.462	167.0	0.252	0.632	.03550	0.912
0.703	0.2073	3.390	35524.	10479.	4708.	6275.		10824.	0.1232	0.0666	1.688	525.0	

LOITER FOR 0.010 HRS. TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	FUEL RATE (LB-HR)	ETAP PROP
CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW (LBS/HR)	BHP		THRUST (LBS)	CP	CT	J	VTIP (FPS)	ETAP
2.434	400.00	12416.6	35524.	0.	87.0	1967.6	P	0.163	87.0	0.131	0.507	4304.	0.760
2.589	0.6306	4.106	35524.	8651.	4304.	3336.		9202.	0.0188	0.0247	0.580	795.3	0.760
2.444	400.00	12459.6	35481.	0.	88.0	1967.3	P	0.163	88.0	0.133	0.511	4303.	0.761
2.528	0.6094	4.148	35481.	8553.	4303.	3331.		9099.	0.0188	0.0244	0.587	795.3	0.761

MISSION FUEL REQUIRED = 12459.62
RESERVE FUEL REQUIRED = 0.0
TOTAL FUEL REQUIRED = 12459.62

V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM   B-93

MISSION PERFORMANCE DATA

CRUISE AT   NORMAL   ENGINE RATING   TEMPERATURE = 59.0 DEG.F

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)	TAS (KTS)	TURB. TEMP. (R)	ENG. CODE	PETF OR PEHF	EAS	MACH	MACH DIV	SPEC. RANGE (NMPP)	ETAP PROP
CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW (LBS/HR)	BHP		THRUST (LBS)	CP	CT	J	VTIP (FPS)	
0.0	0.0	0.0	53461.	0.	219.1	2348.6	Q	1.000	219.1	0.331	0.638	.02768	0.900
0.614	0.1995	3.080	53461.	17356.	7915.	13572.		17613.	0.2664	0.1083	2.214	525.0	
0.005	1.00	36.1	53425.	0.	219.1	2348.6	Q	1.000	219.1	0.331	0.638	.02769	0.900
0.614	0.1994	3.078	53425.	17355.	7915.	13572.		17612.	0.2664	0.1083	2.215	525.0	

MISSION FUEL REQUIRED = 36.12
RESERVE FUEL REQUIRED = 0.0
TOTAL FUEL REQUIRED = 36.12

V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

MISSION PERFORMANCE DATA

TRANSFER ALTITUDE TO 20000. FT.

TIME (HRS)	RANGE (N.M.)	FUEL USED (LBS)	WEIGHT (LBS.)	PRES. ALT. (FT)
0.0	0.0	0.0	53461.	0.
0.0	0.0	0.0	53461.	20000.

CRUISE AT SPEED FOR 99 PER CENT BEST RANGE WITH HEADWIND OF 0.0 KNOTS TEMPERATURE = -12.3 DEG.F

TIME (HRS) / CL	RANGE (N.M.) / CD	FUEL USED (LBS) / L/D	WEIGHT (LBS.) / LIFT (LBS)	PRES. ALT. (FT) / DRAG (LBS)	TAS (KTS) / FUEL FLOW (LBS/HR)	TURB. TEMP. (R) / BHP	ENG. CODE	PETF OR PEHF / THRUST (LBS)	EAS / CP	MACH / CT	MACH DIV / J	SPEC. RANGE (NMPP) / VTIP (FPS)	ETAP PROP
0.0	0.0	0.0	53461.	20000.	203.5	2260.0	P	0.739	148.5	0.331	0.590	.04281	0.886
1.337	.2944	4.541	53461.	11773.	4757.	8757.		12048.	0.3227	0.1390	2.057	525.0	
0.005	1.00	23.4	53438.	20000.	203.5	2259.6	P	0.739	148.5	0.331	0.590	.04283	0.886
1.336	0.2943	4.541	53438.	11769.	4755.	8754.		12044.	0.3225	0.1390	2.057	525.0	
0.005	1.00	23.4	53438.	20000.	203.5	2259.6	P	0.739	148.5	0.331	0.590	.04283	0.886
1.336	0.2943	4.541	53438.	11769.	4755.	8754.		12044.	0.3225	0.1390	2.057	525.0	

MISSION FUEL REQUIRED = 23.36
RESERVE FUEL REQUIRED = 0.0
TOTAL FUEL REQUIRED = 23.36

VASCOMP SAMPLE CASE NO.3 RUN 2

V A S C O M P II
V/STOL AIRCRAFT SIZING & PERFORMANCE COMPUTER PROGRAM B-93

MISSION PERFORMANCE DATA

GROSS WEIGHT = 53461. LB
ALTITUDE = 1000.0 FT
TEMPERATURE = 55.434 DEG.,F.

W/DELTA = 55435. LB
DELTRTH = 0.961
DELTA = 0.964
THETA = 0.993

TAS (KTS)	TOTAL FUEL FLOW (LBS/HR)		THRUST TO WEIGHT	EAS (KTS)	FUEL FLOW PRIM. ENG (LBS/HR)	TURB. TEMP. (R)	PETF OR PEHF	MACH	MACH DIV	SPEC. RANGE (NMPP)	BHP	FM
CL	CD	L/D	LIFT (LBS)	DRAG (LBS)	FUEL FLOW LIFT ENG. (LBS/HR)	J	LETF	CP	CT	VTIP (FPS)	NET THRUST	ETAP PROP
0.0	8250.5		1.122	0.0	8250.5	2395.8	0.722	0.0	0.678	.0	14805.	0.633
----	----	----	53461.	----	0.0	0.0	0.0	0.0849	0.1655	795.3	0.	----
55.1	6626.6		----	54.3	6626.6	2240.3	0.504	0.084	0.018	.008318	10325.	----
9.996	6.9109	1.446	53461.	36960.	0.0	0.368	0.0	0.0619	0.1072	795.3	0.	0.637
60.0	6142.4		----	59.1	6142.4	2192.7	0.436	0.091	0.121	.009768	8939.	----
8.437	4.9730	1.697	53461.	31510.	0.0	0.400	0.0	0.0536	0.0917	795.3	0.	0.685
80.0	5200.1		----	78.8	5200.1	2092.9	0.305	0.121	0.365	.015384	6245.	----
4.746	1.6959	2.799	53461.	19103.	0.0	0.534	0.0	0.0374	0.0561	795.3	0.	0.800
100.0	4938.3		----	98.5	4938.3	2060.9	0.269	0.152	0.478	.020250	5515.	----
3.037	0.8003	3.795	53461.	14086.	0.0	0.667	0.0	0.0331	0.0416	795.3	0.	0.839
120.0	4948.5		----	118.3	4948.5	2062.0	0.271	0.182	0.539	.024250	5554.	----
2.109	0.4787	4.407	53461.	12132.	0.0	0.801	0.0	0.0333	0.0358	795.3	0.	0.861
140.0	5149.2		----	138.0	5149.2	2086.3	0.299	0.212	0.576	.027188	6138.	----
1.550	0.3408	4.548	53461.	11756.	0.0	0.934	0.0	0.0368	0.0346	795.3	0.	0.877
160.0	5537.5		----	157.7	5537.5	2131.5	0.353	0.243	0.600	.028894	7250.	----
1.187	0.2739	4.333	53461.	12339.	0.0	1.067	0.0	0.0435	0.0361	795.3	0.	0.887
180.0	6075.0		----	177.4	6075.0	2185.7	0.433	0.273	0.616	.029629	8874.	----
0.937	0.2382	3.935	53461.	13585.	0.0	1.201	0.0	0.0532	0.0395	795.3	0.	0.892
200.0	6803.8		----	197.1	6803.8	2256.8	0.537	0.303	0.628	.029395	11011.	----
0.759	0.2179	3.485	53461.	15339.	0.0	1.334	0.0	0.0660	0.0444	795.3	0.	0.898
220.0	7761.0		----	216.8	7761.0	2346.7	0.668	0.334	0.637	.028347	13699.	----
0.628	0.2056	3.053	53461.	17512.	0.0	1.468	0.0	0.0821	0.0506	795.3	0.	0.904
225.0	8040.0		----	221.7	8040.0	2372.2	0.705	0.341	0.639	.027985	14461.	----

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0.600   0.2033    2.951     53461.   18114.       0.0   1.501    0.0     0.0867   0.0522   795.3        0.    0.905

          MAIN TRANSMISSION TORQUE LIMIT (ALL ENGINES OPERATING) OCCURS AT
                                      V                =  255.9 KTAS
                                      MAIN ROTOR VTIP  =  795.3 FT/SEC
                                      MAIN ROTOR RPM   =  434.0
                                      POWER            = 20548. SHP
                                      TORQUE           =  248665. FT-LB


                 V(MAX PWR)         =  255.9 KTAS  SPEC.RANGE = 0.0244 NM/LB   Q
                 V(MIL PWR)         =  255.9 KTAS  SPEC.RANGE = 0.0244 NM/LB   Q
                 V(NRP)             =  250.5 KTAS  SPEC.RANGE = 0.0249 NM/LB   T
                 V(BEST RANGE)      =  185.0 KTAS  SPEC.RANGE = 0.0289 NM/LB   P
                 V(99 PERCENT BR)   =  201.0 KTAS  SPEC.RANGE = 0.0286 NM/LB   P
                 V(BEST ENDURANCE)  =  106.7 KTAS  FUEL FLOW  =  5009. LB/HR   P

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END  OF  SUCCESSFUL  CASE

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